OFFICE COPY.

IN THE

Supreme Court of the United States

October Term, ~~1940~~ ~~1941~~ 1954

STATE OF WISCONSIN, STATE OF MINNESOTA, STATE OF OHIO and STATE OF PENNSYLVANIA, Complainants, v. STATE OF ILLINOIS and THE SANITARY DISTRICT OF CHICAGO, Defendants.		No. 2 Original
STATE OF MICHIGAN, Complainant, v. STATE OF ILLINOIS and THE SANITARY DISTRICT OF CHICAGO, Defendants.		No. 3 Original
STATE OF NEW YORK, Complainant, v. STATE OF ILLINOIS and THE SANITARY DISTRICT OF CHICAGO, Defendants.		No. 4 Original

JOINT ABSTRACT OF RECORD

VOLUME I

TESTIMONY

Filed April 30, 1941

The Gilman Press — Madison, Wis.

IN THE

Supreme Court of the United States

October Term, 1940

STATE OF WISCONSIN, STATE OF MINNESOTA, STATE OF OHIO and STATE OF PENNSYLVANIA, Complainants, v. STATE OF ILLINOIS and THE SANITARY DISTRICT OF CHICAGO, Defendants.	No. 2 Original
STATE OF MICHIGAN, Complainant, v. STATE OF ILLINOIS and THE SANITARY DISTRICT OF CHICAGO, Defendants.	No. 3 Original
STATE OF NEW YORK, Complainant, v. STATE OF ILLINOIS and THE SANITARY DISTRICT OF CHICAGO, Defendants.	No. 4 Original

JOINT ABSTRACT OF RECORD

VOLUME I

TESTIMONY

Filed April 30, 1941

The Gilman Press — Madison, Wis.

FOREWORD

While petitioner and respondents have endeavored, for the convenience of the court, to set out in this Joint Abstract of Record the respective portions of the transcript, record and exhibits in these causes which are deemed material for consideration of the issues involved herein, petitioner and respondents have agreed that this Joint Abstract of Record filed herein shall not be construed as barring reference to a consideration of any other evidence appearing in the record which inadvertently may have been omitted from this Abstract of Record.

This Joint Abstract in narrative form of the testimony of the witnesses is not in chronological order nor arranged in accordance with the transcript of the Record, but is grouped according to the nature and character of the evidence. Each witness' testimony has been followed to its conclusion although the witness' testimony may not so appear in the original transcript.

TABLE OF CONTENTS

PART I

EXHIBITS

Exhibits of Illinois

State of Illinois Exhibits	Record Page	Case Page
5—Base map of Sanitary District showing channels, sewers, and sewer treatment works (Record page 8)	242	195
6—Tabulation showing completed work as of December 1, 1938	25	8
7—Tabulation showing expenditures Dec. 1, 1938 to June 1, 1940	26-29	8
	1539-1540	29
9—Estimate of cost of future work after June 1, 1940	32-33	9
	1540-1541	29
	1592	52
10—Future construction program as of June 1, 1940	1541	29
10 A,B,C—Future construction program 1936-1940	36-40	
	3856-3860	83
10 D,E,F—Bring down to date, data on Exhibits 10 A,B,C	3856-3860	83
11—Flow in main drainage channel, yearly averages, 1930-1940	54	13
12—Flow in main drainage channel, monthly averages —1939	55-58	13
13—Flow in main drainage channel, monthly averages for Jan.-May, 1940	62	14
	127-130	20
14—PWA Review Board report, pages 15-17, 44-47, Apr. 30, 1934	73-83	17
15—Supplemental report of Sanitary District filed May 23, 1934, specifically Page 4	84-92	17
16—Report on additions by Engr. Dept., Sanitary District of Chicago, dated April 16, 1940	95-110	17
17—Copy of report of PWA Review Board to Joshua D'Esposito, May 3, 1940	112-117	18

	Record Page	Case Page
18—Letter from Joshua D'Esposito transmitting copy of PWA Review Board Report	118-119	18
19 A,B,C—Certificates from county clerk of Cook County showing assessed values in Sanitary District in 1937, 1938, 1939	119-122	18
20—North Side Works—flow, B.O.D., D.O. and suspended solids, monthly averages, 1929-1940	137-148	89
	1433	106
	1436	107
	1442	107
21—Calumet Works—flow, B.O.D., D.O., and suspended solids, monthly averages 1936-May 1940	152-156	90
	1436	107
	1440	107
22—West Side Works—flow, B.O.D. and suspended solids, 1931-May 1940	158-168	90
	1890	94
	1440	107
	1442	107
23—Southwest Works—flow, B.O.D., D.O., and suspended solids, May 1939-May, 1940	170-171	90
	1442-1444	107
24—Dry solids removed from sewage at Treatment Works,—yearly averages from 1929-May, 1940	183	94
	1446	107
	1458-1459	110
24 A—Showing total average for 1940	3633	185
25—Flow at Treatment Works in million gallons daily from 1928-May, 1940	186	95
25 A—Showing total average for 1940	3638	185
26—Graphic illustration of dry solids removed from sewage in tons per day 1929-May, 1940	183	94
	188	95
	1456	110
27—North Side Works, summary of results of operation, yearly averages 1929-May, 1940	221-223	106
	1446	108
27 A—Total summary for 1940	2642	185
28—Calumet Works, summary of results of operation, yearly averages 1936-May, 1940	224-225	106
28 A—Total summary for 1940	3642	185

	Record Page	Case Page
29—West Side Works, summary of results of operation, yearly averages 1931-May, 1940	226-227	106
29 A—Total summary for 1940	3645	185
31-36—Results of analysis and chart dissolved oxygen and oxygen demands at six stations on the Chicago River, monthly averages, Jan. 1938-June, 1940	250-271	197-200
	1859	210
	1873	216
37—Main channel at Lockport, B.O.D., dissolved oxygen, temp. of water, discharge, 1926-1940	3755	248
	4464	249
37 A—Results through Dec. 1941	4464	249
40—Planned flow and actual discharge of water from main channel at Lockport for 1938, 1939, 1940	1410	21
40 A—Main Channel discharge at Lockport by monthly averages for 1938, 1939, 1940	2672	186
41—Graph—profiles of water surface in Chicago River and Drainage Canal	1415	24
42—Chart—daily discharge at Lockport for 1939, 1940	1418	25
	1591	51
43—Chart—Main channel half hourly discharge at Lockport on 15th of month, 1939, 1940	1418	25
	1567	40
	1585	50
	1587	51
44—North Side Works—Supplemental table flow, B.O.D., D.O. and suspended solids showing June and July including material shown in Exhibit 20	1435	107
45—Calumet Works—supplemental table including June and July, 1940 (flow, B.O.D., D.O. and suspended solids	1438	107
46—West Side Works—supplemental table of flow, B.O.D., D.O. and suspended solids including June and July, 1940	1441-1442	107
47—Southwest Works—supplemental table of flow, B.O.D., D.O. and suspended solids through July and August, 1940	1443-1444	107
47 A—Southwest Works flow—1940	3654	185

	Record Page	Case Page
48—Amount of air used in the various plants of the Sanitary District, average for year cubic feet per gallon of sewage 1930-1940	1450-1451	109
49—Estimated sewage flow, sewage treated and untreated, million gallons per 24 hours, 1930-1940	1453	109
	1465	112
49 A—Estimated flow of sewage plus average for 1940	3656	185
50—Sanitary District yearly record of sludge and grit removed at sewage treatment works from 1929-1940	1460-1461	110
	1463	111
	1465	112
	1472	113
	1475	114
	1485	115
	1628	120
	2520	157
50 A—Corrected copy of Exhibit 50	3660	186
51—Tons of sludge discharged to canal per year for 1929-1940	1467-1468	112
	1475	114
	1638	120
51 A—Retyped copy showing complete figure for 1940	3660	186
52—Record of sludge handling in tons from North Side and Southwest Works from July 1939-July 1940	1472-1473	113
	1638	120
52 A—Retyped copy showing complete figures for 1940	3664	186
53—Record of sludge and grit at Sewage Treatment Works, tons per month—1938	1481-1482	115
	1638	120
54—Record of sludge and grit at sewage Treatment Works, tons per month—1939-1940	1483-1484	115
	1486-1487	115
	1638	120
54 A—Retyped copy including all additional figures	3664	186
58—Photograph showing disturbance of surface sludge caused by ship passing in Sanitary Canal	2137	334
	3386	484
59—Enlargement of Exhibit 58	2139	334
	3386	484

	Record Page	Case Page
60—Estimates of B.O.D. and dissolved oxygen sources and conditions from Lake Michigan to Lockport, —June, 1938-1944	3528	
	3761-3767	187
	3940	188
	4034-4062	189-190
60 A—Revised compilation of Exhibit 60	4034-4062	189-190
61—Estimates of B.O.D. and dissolved oxygen sources and conditions from Lake Michigan to Lockport, June, July, August, 1938-1944	3529	
	3761-3767	187
	3940	188
	4034-4062	189-190
	3755	248
61 A—Revised compilation of Exhibit 61	4034-4062	189-190
62—Diversion from Lake Michigan—monthly discharge for 1938, 1939, 1940	3673	186

Gayton Exhibit

1—Affidavit of Loran D. Gayton, Engineer in Department of Public Works, Chicago	3538-3545	336

Mohlman Exhibits

1—Determination of Chlorine Demand—Main Channel —July 2 & 3, 1940	1820	206
	2263	445
2—Report: "Chlorination in Sewage Treatment", Amer. Pub. Health Assn.	1826	207
	2917	413
3—"Reduction of Biochemical Oxygen Demand by Chlorination"—Reprint	2412	220
4—Blue print showing cross section of drainage canal at Lockport	2425	222
5—Record of Chlorination, 1939 at Morton Grove and Glenview Works	2433	223
6—Table and graph showing analysis of sludge of Nov. 20, 1935	2445	224
	2441	224
	2440	223
	2448	224
	2454	225
	2500	226
	3736	245

	Record Page	Case Page
7—Table and graph showing oxygen demand of sludge from main channel at Lockport	2441	224
	2456	225
	2500	226
	3706	242
	3736	245
8—Photostat of editorial by Mohlman in Sewage Works Journal	2445	224
9—Translation and photostat: Imhoff's Handbook on Sewage Disposal	2448	224
10 A, B, C, D & E: Volatile Suspended Solids Discharged to Channel from various sources, 1939 to 1940	2502	227
11—Analysis of Howson Exhibit 10, Sources of Oxygen for prevention of complaints at Brandon Pool	3278	228
12—Discussion of Howson Exhibit 11, means of reducing B.O.D. load to canal	3298	230
13—Extension of Mohlman Exhibit 10 showing 1939-1943	2514	228
	3303	231
13 A—Extension of Mohlman Exhibit 10 showing 1936-1943	3755	248
14—a—Basis for estimating additional diversion needed in summer	3530	233
	3620	239
b—Analysis at Lockport of diversion, 1940		
c—Proposed increase of diversion for 1941		
d—Proposed increase of diversion for 1942		
e—Basis for estimating diversion needed in summer at Brandon Pool		
15—Record of dry volatile solids discharged to canal	3311	232
	3530	233
	3604	236
16—Letter dated Nov. 28, 1940 showing scheme of sampling and analyses	3590	234
17—Summary and conclusions of a report on the flushing experiment. Jan 13, 1941. (Booklet form)	3595	234
	3873	374
	3886-3888	380-381
	3895-3898	383-385
	3903	386
	3916	390

	Record Page	Case Page
18—a—Dissolved oxygen and B.O.D. at Lockport, Jan. 1938, to 1941	4015	249
b—Total discharge at Lockport, Jan. 1938 to 1941		
c—Dissolved oxygen and oxygen demand at Summit, Jan. 1938 to 1941.		
d—Dissolved oxygen and oxygen demand at Lockport, Jan. 1938 to 1941		
19—Sewage disposal and stream pollution and sludge disposal	4000-4009	249
20—Table showing results of analysis for dissolved oxygen and B.O.D. at Lockport for January, 1941	4464	249
Muehlberger Exhibits		
1—General orders on dusts, fumes, vapors and gases. Issued by Industrial Commission of Wisconsin	2799	300
Pearse Exhibits		
1—Record of air used, Sanitary District of Chicago, cubic feet per gallon of sewage, 1928-1940	1665	126
1—Weight and volume of sludge discharged to main channel July 1939-Aug. 1940 (Rec. 2523)	2522	158
2—Southwest Intercepting Sewer System, number of sewers connected and estimated dry weather flow, June, 1930-May 1940	2539	161
3—Calumet Sewage Works, record of air used Jan. 1939-Aug. 1940	2564-2568	164-165
4—Division of flow—West-Southwest Works May 1939-Aug. 1940	2734	176
4 A—Revised table showing figures from May 1939-Dec. 1940	3670	186
12—Sanitary District of Chicago estimates of B.O.D. and dissolved oxygen Lake Michigan to Lockport, June 1938-1943	3343	181
13—Sanitary District of Chicago estimates of B.O.D. and dissolved oxygen Lake Michigan to Lockport, June, July and August, 1938-1943	3348	182
15 A & B—Memo on lagooning	4074	191
16—Weighted averages, Major Works, 1940	4199	192

	Record Page	Case Page
Ramey Exhibits		
1—Average time of flow, Damen Ave. to Brandon Road Dam	2219	70
2—Average time of flow, Damen Ave. to Brandon Road Dam	2219	70
3—Blue print of Brandon Road Pool showing location of cross-section and drift of current—Dec. 9, 1940	3844	78
	3846	78
	3851	81
4—Blue print of cross section of Brandon Pool soundings, Dec. 9, 1940	3845	78
	3848	80
	3851	81

EXHIBITS

Exhibits of Master

Andrew Exhibits		
1—Photograph: Aerial view of Brandon Pool and Locks	1496	249
	1499	250
6—Map of Brandon Road Pool	3846	79

EXHIBITS

Exhibits of Wisconsin et al.

State of Wisconsin Exhibits		
7—Tests of air made in the vicinity of Joliet and Lockport along the Illinois Waterway	2639-2646	536
	2650	537
	2648	537
	2722-2724	537
15—Report of tests and analyses of water, air and scum at Brandon Road Pool	3103	503
16—Photo. enlargement of Opponent's Exhibit 8 showing section of Sanitary District Canal taken from South Bank of canal at U.S.H. 45 bridge, Sept. 24, 1940, at 1:40 P.M.	3386	484

	Record Page	Case Page
Enslow Exhibit		
1—Chlorination in sewage disposal—discussion of the report of the A.P.H.A.	2912-2917	413
Howson Exhibits		
1—Diagram illustrating effect of flushing test at Brandon Pool	3875-77	375
2—Diagram illustrating effect of lowered pool level at Brandon Pool	3884-3888	379-381
	3891	381
3—Effect of lowering Brandon Pool one foot on tonnage carried through Pool	3889-3891	381-382
4—Effect of lowering Brandon Pool on B.O.D. and volatile solids	3893	383
	3910	389
5—Analysis of Mohlman's Exhibit 17 to determine effect of lowering Brandon Pool level	3911-3915	389-390
8—Chart showing use of water per capita	2814-2822	343
9—Orders and reports relative to metering of Chicago water supply	2822-2825	343
10—Sources of oxygen for prevention of complaints from Brandon Pool	2825-2832	343
	3218	347
	3220	348
	3254	363
	3278	228
11—Means of reducing B.O.D. load to canal	2832	343-344
	2839	344
	2840	344
	2862	346
	2870	347
	3221	349
	3229	352
	3254	363
	3263	368
	3291	230
	3301	230-231
	3302	231
	3343	181
	3344	181

	Record Page	Case Page
12—Estimated cost of measures to remedy conditions complained of at Brandon Pool	2833-2840	343-340
	2845	345
	2862	346
	2870	347
	3217	347
	3221-3222	349
	3230	353
	3254	363
	3273	372
	2946	423
	3220	348
	3357	182
13—Sources of B.O.D. of canal at Lockport	2852	345
	3229-3230	352
	3254	363
	3332	181
	3372	184
	3375	184
14—Estimates of B.O.D. and dissolved oxygen	3230-3231	352-353
		363
	3260	366
	3348	182
	3332	181
	3375	184

McNally Exhibits

1—Physiological Response to Hydrogen Sulphide, excerpt from article in Am. Jour. of Public Health	2687	498
2—Odor intensities for various concentrations of H2S	2689-2690	499

	Record Page	Case Page
PART I		
WITNESSES		
Witnesses of Illinois		
Adams, Charles L.		
Direct examination	228-233	336
Calvert, C. K.		
Direct examination	2609-2634	263-272
Cross-examination	3161-3191	272-279
	3193-3197	279-280
Examination by the Master	3192-3193	279
	3204-3205	282
Redirect examination	3198-3204	280-282
Recross examination	3205	262
Carlson, Anton Julius		
Direct examination	2873-2895	282-286
Examination by the Master	2897-2904	286-287
	2980-2983	289-290
	2985-2986	300-301
Cross-examination	2971-2979	288-289
Redirect examination	2983-2984	290-291
	2987	292
Recross-examination	2988-2990	292-293
	2991-2992	293-294
Ivy, Dr. Andrew Conway		
Direct examination	3032-3047	304-312
Cross-examination	3048-3054	313-316
	3054-3059	313-318
	3059-3065	319-322
(Master)	3065	322
	3067-3075	322-325
	3076-3077	325-326
Redirect examination	3077-3078	326
Recross-examination	3078	326-327
McGuigan, Hugh Alister		
Direct examination	3079-3086	327-329
Cross-examination	3087-3089	330
	3089-3090	330-331
	3091-3093	331-332
	3093-3094	332
	3094-3095	332
(Master)	3095-3096	332-333
	3096-3097	333
	3098	333

	Record Page	Case Page
Mohlman, Dr. Floyd W.		
Direct examination	234-283	193-204
	1420-1426	205-206
Cross-examination	1819-1879	206-217
	1882-1918	217-220
	2414-2462	220-225
	2492-2518	226-228
	3382	232-233
	3699-3764	241-249
Redirect examination	3278-3309	228-232
	3589-3627	233-240
Examination by the Master	3310-3312	232
	3530	233
Muehlberger, Dr. Clarence W.		
Direct examination	2780-2807	302
Cross-examination	2808	302
Examination by the Master	2809-2811	303-304
Pearse, Langdon		
Direct examination	131-227	87-106
	1433-1493	106-117
	3313-3341	179-181
	3633-3770	185-187
Cross-examination	1629-1692	118-132
	1699-1726	134-140
	1728-1800	140-157
	2520-2550	157-162
	2555-2597	162-173
	2606	175
	2730-2755	175-178
	3343-3385	181-185
	4033-4057	189-190
	4065-4078	191-192
The Master's examination	1692-1698	132-135
	2598-2601	173-174
	2757-2759	178-179
	3932-3942	187-189
	4058-4065	190
Explanation requested by the Master	4199-4200	192
	4499	192
Ramey, Horace P.		
Direct examination	9-130	1-20
	1409-1418	21-25
Cross-examination	1531-1626	26-65
	1803-1817	65-69
	2217-2224	70-72
	3825-3828	72-73
	3836	76

	Record Page	Case Page
	3837-3838	77
	3854-3855	82-83
The Master's examination	3829-3835	74-76
	3837	76
	3838-3840	77
	3840-3842	77-78
	3842-3853	78-82
	3861-3863	84-85
	3868	86
	3869	87
Redirect examination	3840	77
	3842	78
	3855-3856	83
Recross-examination	3856	83
	3864-3867	85-86
	3868	86
	3870-3871	87
Schwob, C. E.		
Direct examination	2136-2142	333-334
Cross-examination	2143	334

PART I

Witness of Master

Andrew, C. R.		
Direct examination (by the Master)	1496-1510	249-252
	1516-1518	253
	1521-1523	254
	2031-2041	255-256
Cross-examination	1510-1513	252
	1513-1515	253
	1519-1520	254
	1523-1524	254
	1524	255
	2043-2051	256-257
	2052-2056	257
	2057-2058	258
Examination by the Master	2727-2728	258
	3581-3588	258-259
	3781-3802	259-262
	3810	262
	3817	263
Examination	3802-3810	262
	3811	263
	3819-3821	263

	Record Page	Case Page
PART I		
Witnesses of Wisconsin et al.		
Bergman, Willard L.		
Direct examination	2635-2637	485
(By the Master)	2637	485
Buswell, Arthur M.		
Direct examination	1888-1898	431
	2214-2216	437-438
Examination by the Master	1898-1900	436-437
	2254-2256	441-442
	2262	444
	2266	446
Cross-examination	2250-2254	439-441
	2257-2262	442-444
	2263-2266	445-446
	2267-2295	446-453
Ellms, Joseph W.		
Direct examination	2086-2097	454-458
Cross-examination	2296-2331	458-474
Master (Question)	2328-2329	473
Enslow, Linn H.		
Direct examination	1968-2028	392-408
	2070-2085	408-412
Recalled by the Master	2098-2100	412-413
Question by the Master	2954	425
Cross-examination	2907-2947	413
Redirect examination	2947-2964	423-429
	3213-3216	429-431
Enzer, Dr. Norbert		
Direct examination	2145-2153	538-541
Cross-examination	2153-2157	541-543
	2158-2159	543-544
(Master)	2159-2167	544-548
	2167-2173	548-550
Redirect examination	2173-2174	550-552
	2176	552
Recross-examination	2175	552
	2176-2177	552-553
Gute, Dr. Edwin B.		
Direct Examination	2209-2210	565

	Record Page	Case Page
Howson, Louis R. (A witness called on behalf of Wisconsin et al.)		
Direct examination	1935-1952	338-340
	2812-2852	342-345
	2862	346
	3873-3878	374-376
Cross-examination	1953-1966	340-342
	2865-2870	346-347
	3217-3258	347-365
	3903-3911	386-389
Examination by the Master	2854-2860	345
	3260-3263	366-368
	3878-3902	376-386
Redirect examination	3259-3260	366
	3273-3276	372-373
Recross-examination	3263-3272	368-372
	3913-3931	389-392
Jenkins, Robert C.		
Direct examination	2639-2648	536-537
Cross-examination	2724-2727	537-538
Krumbiegel, Dr. Edward Richard		
Direct Examination	2178-2180	553-554
Cross-examination	2180-2186	554-556
	2186-2189	557-558
(Master)	2190-2196	558-560
	2196-2197	561
Redirect examination	2198	561
	2200	562
(Master)	2200-2201	562
	2202	562
Recross-examination	2203-2204	563
	2204-2208	563-565
McNally, Dr. William D.		
Direct examination	2659-2679	487-494
Cross-examination	2680-2698	495-501
Redirect examination	2699-2700	501
	2702	502
Recross-examination	2701	501
Moore, Dr. Josiah		
Direct examination	2649-2653	530-532
Examination by the Master	2654-2655	532
	2657-2659	532-533
	2769-2771	534-535
Cross-examination	2656	532
	2764-2769	533-534
	2771-2772	535
Redirect examination	2773	535-536

	Record Page	Case Page
Nichols, Dr. M. Starr		
Direct examination	3100-3117	502-506
(Master)	3117-3119	506-507
	3119	507
(Master)	3120	508
	3121	508
(Master)	3121-3126	508-509
	3128-3136	510-512
Cross-examination	3137-3147	513-515
(Master)	3148-3150	516-517
	3150-3152	517-518
(Recalled)	3208-3210	519-520
Redirect examination	3154	518
(Master)	3155-3156	518-519
	3211	520-521
Recross-examination	3157-3158	519
	3211	521
Perkins, Dr. James Eliab		
Direct examination	2465-2471	521-526
Cross examination	2473-2483	526-528
	2484-2489	529-530
(Master)	2491	530
Warrick, Louis F.		
Direct examination	2100	475-477
	2119-2120	477-478
	5586	484
Examination by the Master	2110-2112	477
	2236-2239	480-481
	2245-2248	483-484
Cross-examination	2226-2232	478-479
Redirect examination	2233-2236	479-480
Recross-examination	2240-2244	481-482
	2249	484

PART II

WITNESSES OF ILLINOIS

Medical and Lay Witnesses at Joliet, Illinois

	Record Page	Case Page
Altenhoff, Mrs. Ray	1233-1237	677-678
Anderson, Mrs. Ella	666-673	613-614
Argendalis, James	1272-1277	680-681
Avon, Joseph	612-615	607
Bach, Rev. Constantine	373-377	578
Bautino, Elizabeth	1315-1317	687
Beck, Peter	1217-1223	675-676
Beckwith, Dr. Henry M.	927-932	639
Beebe, Stuart	1174-1179	667-668
Bianchi, Mrs. Elma	998-1002	645-646
Blatchley, Clarice	401-418	582-584
Blood, Willard G.	1072-1075	555
Boles, Dr. Donald	1318-1326	687-688
Bolte, Joseph	698-702	617
Bonakes, James	1265-1269	680
Booklund, Mrs. Beulah	905-917	638-639
Boswell, Otto	814-817	627-628
Britz, Walter	688-693	615-616
Burnette, Sister	1118-1127	658-659
Busanelli, Mrs. Irma	849-851	632
Bush, Mrs. Marie	331-357	575-576
Calamaris, Thomas	607-609	606
Callahan, Edward P.	859-868	633-634
Calosis, Dr. Richard	1003-1009	646-647
Cattaneo, Peter	640-649	610-611
Cervellotti, Mrs. Laura	717-721	620
Cheadle, Bruce D.	420-439	584-586
Christmann, Adam	622-633	608-609
Chrzanowski, Helen	1254-1259	679
Cleopha, Sister	1207-1210	673-674
Colvon, Mrs. Evelyn	1065-1067	653-654
Conlen, Mrs. John	1260-1265	679-680
Costello, Leo	596-606	604-606
Costello, Michael	677-681	614-615
Coyne, Richard J.	1076-1082	655-656
Crespi, Mrs. Josephine	706-708	618-619
Curtiss, Dr. Charles	547-591	601-604
Datozech, Mrs. Louis	1227-1230	676-677
Deneau, William M.	768-801	624-626
Deprat, Ben	1062-1064	653
Dolorita, Sister	1145-1147	662-663
Donna, Charles	852-855	632-633
Donovan, Thomas F.	360-368	576-577
Downey, Rosa	1281-1283	682

	Record Page	Case Page
Elfder, Mrs. Anna	1232-1233	677
Erickson, Lydia	650-654	611-612
Evangelisten, Sister	1188-1193	670-671
Faulkner, Dr. George	933-956	640-642
Fox, R. A.	756-767	623-624
Frederick, Dr. Louis J.	442-465	586-590
Garavolia, Mrs. Louise	845-848	631-632
George, Sister Mary	1211-1214	674-675
Grassle, Herman C.	506-516	594-596
Griggs, Leon	1058-1061	653
Hanson, Nellie Patterson	702-705	618
Harper, Mrs. Gertrude	1184-1188	669-670
Heggie, Janet	1341-1347	691-692
Heinzel, Stephen J.	617-621	607-608
Hicks, Mrs. Rosalie	1022-1027	648-649
Hilda, Sister	1109-1117	657-658
Himes, Helen	1312-1315	686-687
Hollis, Loretta	1326-1333	689-690
Hortense, Sister	1133-1140	660-661
Huberta, Sister	1128-1132	659-660
Imfeld, Peter	1278-1280	681
Irmengard, Sister	1155-1158	664-665
Jeffrey, Mrs. John	1163-1169	665-666
Jones, George T.	290-306	569-571
Joseph, Sister Alma	1203-1206	673
Jovita, Sister Mary	1180-1184	668-669
Keigher, Mary Virginia	1069-1071	654
Kennedy, Dr. Raymond J.	1148-1151	663
Kerwin, William	693-697	616-617
Koehl, Catherine	1303-1308	685
Lawler, Mrs. Catherine	723-727	620-621
Lavazza, Peter	1052-1055	652-653
Lennon, Dr. Robert W.	526-538	598-600
Logan, Mrs. Stella	1170-1172	666-667
Louise, Sister Emma	1197-1202	672
Low, Frances	1239-1245	678
Marietta, Anna	752-755	623
Martin, Mrs. Robert W.	610-612	606-607
McCormick, Mrs. Florence	1032-1036	649-650
McGarry, Miss Mary	662-664	613
McGinnes, Jr., Dr. Philip C.	963-980	642-644
Melitta, Sister	1153-1155	663-664
Misichia, Dr. Cosmo	1037-1047	650-651
Mitchell, Mrs. Robert	655-660	612-613
Mohr, Harry	869-870	634
Momper, Mary Elizabeth	1193-1197	671-672
Muentnick, Mrs. Gertrude	709-715	619
Nichols, J. G.	1301-1302	684
O'Daniel, Mrs. Jesse	1298-1300	684

	Record Page	Case Page
Oiselle, Eward	1334-1337	590
Pascline, Sister	1141-1144	661-662
Pellino, John	728-745	621-622
Pesteris, Mrs. Lena	1028-1032	649
Peterson, Leona	1215-1216	675
Petronia, Sister	1159-1161	665
Polmonari, Mrs. Palma	829-833	629-630
Poole, Mrs. Vina	634-639	610
Powers, Ray	314-318	572-573
Raue, Harold	319-331	573-575
Renkenberger, Mrs. Opal	825-828	629
Renger, Mrs. Mellison	1245-1254	679
Residori, Arthur	802-813	626-627
Rooney, Dr. George W.	1283-1296	682-684
Ryan, Mrs. Martin	993-997	645
Saffold, Mrs. James	1050-1052	652
Sampson, Harry	307-313	571-572
Santini, Charles	684-687	615
Seeber, Mrs. Sophie	1224-1226	676
Shea, Raymond	516-520	596-597
Sherman Leroy	818-825	628
Sontag, Howard	390-400	580-581
St. Germain, Mrs. Mable	987-992	644-645
Steen, Dr. Earl R.	1015-1021	647-648
Stobbeona, Dan	834-841	630-631
Swanco, Mrs. Ray	746-751	622-623
Testim, Thomas J.	1357-1398	692-698
Ursuline, Sister	1099-1108	656-657
Velt, Rose	1309-1311	685-686
Volgar, John	1338-1340	691
Wagner, Dr. Thomas H.	876-898	634-638
Wilcox, Dr. G. J.	471-490	590-592
Woodruff, Dr. H. W.	496-505	593-594
Woodruff, Dr. Lewis W.	521-526	597-598
Wurtz, Mary S.	377-389	578-580

	Record Page	Case Page
PART II		
WITNESSES OF MASTER		
Detweiller, Thomas H.		
Master's examination	2344-2347	709-710
Cross-examination	2347-2348	711
Goodell, Harry L.		
Master's examination	2385-2400	718-721
	2403-2404	722
Cross-examination	2402-2403	722
	2405-2409	723
	2409-2410	723-724
Kerr, Dr. J. P.		
Master's examination	2351-2375	711-717
Cross-examination	2376-2383	717
Moore, George Patrick		
Master's examination	2332-2336	707-708
Cross-examination	2338-2339	708
(Master)	2339-2340	708
	2340-2341	708-709
(Master)	2341-2342	709

Part One

TECHNICAL AND SCIENTIFIC EVIDENCE

IN THE

Supreme Court of the United States

October Term, 1940

STATE OF WISCONSIN, STATE OF MINNESOTA, STATE OF OHIO and STATE OF PENNSYLVANIA, Complainants, v. STATE OF ILLINOIS and THE SANITARY DISTRICT OF CHICAGO, Defendants.	No. 2 Original
STATE OF MICHIGAN, Complainant, v. STATE OF ILLINOIS and THE SANITARY DISTRICT OF CHICAGO, Defendants.	No. 3 Original
STATE OF NEW YORK, Complainant, v. STATE OF ILLINOIS and THE SANITARY DISTRICT OF CHICAGO, Defendants.	No. 4 Original

JOINT ABSTRACT OF RECORD

VOLUME I

Page of Record

HORACE P. RAMEY, duly sworn for Defendants,
Direct Examination by Mr. Clausen.

9 Reside Chicago, Illinois; graduated from high school,
10 Carlisle, Kentucky; two years literary work, Kentucky State University; then four years Civil Engineering, University of Michigan, graduating 1907. Later, Degree Civil Engineer, 1917, from University of Michigan. Worked for Sanitary District since 1907, as rod man,

computer, instrument man, assistant engineer, resident engineer, division engineer, acting chief engineer 1922, assistant chief engineer since January 1, 1923; worked on surveys and construction 1907 to 1910 of Lockport Power House; worked on construction of Lockport Power House 1907; on surveys and construction of North Shore Channel 1908 through 1910; construction of eight-track bridge 1909; designed Calumet-Sag Channel; in charge of maintenance and operation of works of Sanitary District 1912-1920; made economic studies 1921 leading to outline of present sewage treatment program; since July 1925 in charge of all design work of Sanitary District.

11 The 442 square miles of area in the Sanitary District of Chicago is divided into four projects for purposes of sewage treatment (North Side project, Calumet project, West Side project, Southwest Side project).

The North Side project covers 115 square miles, north of Fullerton Avenue, Chicago, to the north line of Cook County, and from Lake Michigan to the watershed between the Des Plaines and Chicago Rivers. This project consists of a sewage treatment plant, located at Howard Avenue and the North Shore Channel and about 39 miles of intercepting sewers, extending south from Glencoe through the North Shore towns and Evanston to the treatment plant and extending north from Fullerton Avenue to the treat-
12 ment plant. The treatment plant is of the activated sludge type and at present serves a sewered area of 82.5 square miles. The treated effluent is discharged into the North Shore Channel and the waste sludge from the plant is pumped through a 14-inch pine line,

17.5 miles long, to the Southwest Treatment Works for disposal. This treatment plant was placed in partial service October 3, 1928 and in complete operation June 28, 1930. The plant was originally designed for an average flow of 175 M.G.D. and in May 1937 by the addition of 12 new final settling tanks, this average capacity was increased to 250 M.G.D. At this plant, sewage passes through bar screens, with 4-inch
13 openings, is then pumped up 36 feet; then passes through grit chambers; then through bar screens with 5/8 inch openings, then through preliminary settling tanks (detention period 20 minutes); then through aeration tanks (detention period 5 hours); then through final settling tanks where the activated sludge is settled out and from which the effluent passes to the North Shore Channel. Approximately 20 per cent of the activated sludge taken from the final settling tanks is added to the fresh sewage just before it is passed into the aeration tanks. The remaining activated sludge (waste sludge) is combined with the sludge collected from the preliminary settling tanks and pumped through the 14-inch pipe line to the Southwest Treatment Works. Air for the aeration of sewage in the aeration tanks is provided by electrically driven blower units, compressing the air to 7.75 pounds per square inch. All the pumping units and other mechanisms in this plant are electrically driven.

14 The Calumet Sewage Treatment Project covers an area of 95 square miles, south of 87th Street, in Chicago, to 159th Street and from the Indiana State line west to Kedzie Avenue. This project covers the Calu-

met industrial district and the municipalities immediately south of Chicago. The project consists of the Calumet Sewage Treatment Plant of the activated
15 sludge type and about 42 miles of intercepting sewers, draining a sewered area of 42.6 square miles. The collecting sewers lead to the plant from the 95th Street pumping station on the Calumet River from Harvey, from Calumet City, and from Blue Island. This plant was placed in service December 3, 1935, and was designed for an average flow of 136 M.G.D. with a maximum of 200 M.G.D. At this plant the sewage passes through rack screens with 4-inch openings; is then pumped up 33 feet; then passes through bar screens
16 with 5/8-inch openings; then through preliminary settling tanks (detention period 10 minutes); then after dosing with returned activated sludge passes through aeration tanks (detention period 5 hours); then through final settling tanks where the activated sludge is settled and from which the effluent passes to the Calumet-Sag Channel. Approximately 20 per cent of the activated sludge is added to the raw sewage before aeration. The remaining activated sludge (waste sludge) is combined with the sludge from the preliminary settling tanks; it is dosed with ferric chlor-
17 ide and dewatered to about 80 per cent moisture on vacuum filters; then broken up and mixed with predried sludge, the mixture placed in flash dryers, in which it is dried down to 6 per cent moisture; and this final dried material is then burned in a furnace which provides the heat for drying. This dried sludge can be used as a fertilizer. When dried sludge is re-

moved for sale as a fertilizer the heat for drying is supplied by the combustion of fuel oil.

The West Side Sewage Treatment Project covers
18 an area of about 40 square miles, in Chicago, between Fullerton Avenue and Taylor Street, and between Lake Michigan and Cicero Avenue. This includes the "Loop" district of Chicago. This project consists of the West Side Sewage Treatment Works, at Laramie Avenue and 39th Street, and 22.2 miles of intercepting sewers paralleling both sides of the Chicago River and the northwest side of the Drainage Canal, leading from Fullerton Avenue, southwest to the treatment works. The West Side Sewage Treatment Plant was designed for an average flow of 472 M.G.D., with a maximum of 700 M.G.D. The plant consists principally of three batteries of Imhoff tanks for the sedimentation of sewage and the digestion of sludge. Battery A of the Imhoff tanks was placed in service June 2, 1930; Battery B on July 14, 1930; Battery C
19 on April 29, 1935. At this plant the sewage passes through rack screens with 4-inch openings; is then pumped up 61 feet; then passes through bar screens with 1-inch openings; then passes through skimming tanks, from which the surface flow passes to the Imhoff tanks (Detention period 2 hours, Batteries A and B; 1 hour, Battery C) where the sludge is settled from the sewage and digested and from which the effluent passes to the Main Channel. The underflow from the skimming tanks is diverted to grit chambers where the grit is settled out and from which the flow is passed to the Imhoff tanks. The grit is collected and hauled for final disposal to a spoil pile. The solids settled from the

sewage in the Imhoff tanks pass down into the digestion
20 compartment of these tanks and remain until thoroughly digested. The digested sludge is drawn out under favorable weather conditions and placed on sludge drying beds from which after suitable drying it is stripped by machines and hauled away to the waste sludge dump.

The Southwest Sewage Treatment Project covers an area of about 192 square miles, between 87th Street and Taylor Street, in Chicago, and west from Lake Michigan, to include the Summit-Clearing industrial district. This project also includes the towns in the Des Plaines River Valley from Riverside, north to Des Plaines. At one time, this Des Plaines Valley was served by a separate treatment plant at Maywood but this plant was abandoned October 15, 1931 and the flow from it then absorbed in the West Side project, and to be ultimately absorbed in the Southwest Side project.

21 The West-Southwest Treatment Works now serve a sewered area of 125 square miles drained by 67 miles of intercepting sewers. The sewage treatment plant is of the activated sludge type, was originally designed for an average flow of 400 M.G.D. with a maximum of 600 M.G.D. This plant, as presently constructed, has been designated the "Southwest Side Treatment Plant" for treatment of sewage from the southwest area, including Packingtown and the Stockyards. This plant is to be extended to provide final treatment for the West Side sewage and as a consequence is designated the "West-Southwest Sewage Treatment Works". The Southwest Side Plant was placed in partial service May 23, 1939 when sewage was pumped from the West Side

intercepting sewer. The activated sludge was started June 9, 1939 and by June 27, 1939 the first battery of aeration tanks was in service. Dewatering and incineration of sludge began August 7, 1939 and the first part of the plant has operated continuously since August 28, 1939. The Southwest intercepting sewer was placed in service September 7, 1939, draining sewage from an area west of Western Avenue. The remaining part of this sewer system, including the Racine Avenue Pumping Station ,was placed in service March 20,
22 1940. At the Southwest Plant, the sewage passes through bar screens, with 2-inch openings; is then pumped up 45 feet; then passes through preliminary settling tanks (detention period 34 minutes); then through aeration tanks (detention period 5 hours) then through final settling tanks where the activated sludge is settled and from which the effluent passes to the Main Channel. Approximately 20 per cent of the activated sludge (return sludge) is mixed with the raw sewage just before it enters the aeration tanks. The remaining sludge (waste sludge) is passed to concentration tanks where it is mixed with sludge from the preliminary settling tanks, also, with waste sludge which
23 has been pumped from the North Side Treatment Plant. The main sewage pumps are steam turbine driven and air for aeration of sewage and other plant uses is produced by steam turbine driven blowers which compress the air to a pressure of 7.75 pounds per square inch. The waste sludge for concentration in the sludge concentration tanks is conditioned with ferric chloride and dewatered to about 80 per cent moisture on vacuum filters. This dewatered sludge is mixed with pre-dried

sludge and the mixture placed in an enclosed flash
24 dryer and dried down to about 6 per cent moisture. This dried sludge is then burned in furnaces under the boilers which produce steam for the pumping and blower units, or the dried sludge can be removed from the system and sold as a fertilizer base. When sludge is sold as a fertilizer, approximately one-half ton of coal is required to furnish heat for drying one-ton of sludge.

25 Illinois Exhibit No. 6 was received in evidence. This exhibit is a tabulation showing the completed work on the sewage treatment construction program of The Sanitary District of Chicago up to December 1, 1938, in the amount of $159,795,331.70.

26-29 Illinois Exhibit No. 7 was received in evidence, being a tabulation of the expenditures of the Sanitary District on sewage treatment construction from December 1, 1938 to June 1, 1940, in the amount of $5,311,188.12.

30 Regarding the Southwest Side Project and the West-Southwest Treatment Plant: In the reports made to the Supreme Court the cost figures for Southwest Side project include only the cost of sewers on the southwest area and the Racine Avenue Pumping Station, which is a part of the sewer system. The West Side Project includes the West Side sewers as well as the West Side Treatment Plant. The West-Southwest Plant, shown on such tabulations, includes the activated sludge sewage treatment plant, which has formerly
31 been referred to as the "Southwest Side Plant". This has been given the hyphenated name "West-Southwest Side Sewage Treatment Plant", because ultimately it will provide complete treatment for the Southwest Side sewage and also provide final treatment for the West

Side sewage. At the present time, only Southwest Side sewage is being treated at the West-Southwest Plant.

I have prepared an estimate of cost of future work of sewage treatment construction after June 1, 1940.
32-33 This amounts to $12,969,092 and is shown on Illinois Exhibit No. 9. This future work consists of $912,192 remaining unpaid on 27 existing contracts and of $12,-056,900 of estimated future work. The 27 contracts
34-40 are actual commitments, most of which are well under way. The future work is divided into certain prospective contracts. These future estimates are based on the best judgment of the engineering department of the Sanitary District and on its past experience in constructing work of similar nature. The future work consists principally of $10,554,900 for construction and equipment sufficient to increase the capacity of the West-Southwest Treatment Works so that it will be able to handle 900 M.G.D. of sewage, of which sewage 600 M.G.D. would be given complete treatment and 300 M.G.D. would be effluent from the West Side Sewage Treatment Plant, which is to be given secondary or final treatment in the West-Southwest Plant.

41 The Sanitary District has available at present sufficient resources to pay for approximately 90 per cent of this construction work. On June 1, 1940, the Sanitary District had cash, or equivalent, in its funds for construction of $1,308,942; then, in addition, the Sanitary District on June 27, 1940 sold bonds in the amount of $5,000,000; after the sale of these bonds the Sanitary District had $2,455,000 of unencumbered debt incurring capacity and on July 1, 1940 redeemed $3,000,000 of bonds, after which there was $5,455,000 of unencum-

bered debt incurring capacity in addition to the $6,308,-942 cash on hand June 1 and cash from bonds sold June 27, 1940. This should cover all the construction work which can be done up into 1942.

42 The bonding capacity of the Sanitary District is five per cent of the assessed valuation of the property within the Sanitary District. At the present time, there is about $5,400,000 of unencumbered capacity and bonds are being redeemed at about the rate of $5,000,000 per year, so that if the assessed valuation of property of the Sanitary District should remain approximately the same in 1941 and 1942 as at present, there should be available about $5,000,000 additional each year to carry on the work.

43 At present, the Sanitary District has approximately $6,308,000 cash on hand and a bonding capacity of approximately $5,400,000 in addition, or total resources of approximately $11,700,000 to date. This additional
44 future construction work will cost approximately $13,-000,000 so we lack only about $2,000,000 today of enough money to complete this future construction, assuming that all these funds can be used for this purpose. There is a possibility of other liabilities against the Sanitary
45 District, a judgment, for instance. The Sanitary District is now engaged in patent litigation; is being sued for the infringement of certain patents. Approximately $5,000,000 of bonds are being retired each year by the use of taxes collected for the redemption of bonds and when $5,000,000 of bonds are retired it then becomes possible to resell such an amount of bonds. At the present time the Sanitary District has outstanding
46 $110,000,000 of bonds. The Sanitary District has ap-

proximately $6,000,000 in cash for construction at present and in addition has an unencumbered debt incurring capacity of about $5,000,000. This relates to future construction of approximately $13,000,000 which will take about 2-½ years from now to complete. During that period of 2-½ years, the Sanitary District will have the benefit of additional debt incurring capacity over and above the approximately present $11,000,000 when and as bonds are redeemed and if the assessed valuation
47 is not reduced, and in another 2 years, on the present assessed valuation, the Sanitary District would have an additional $10,000,000 which would increase potentially the present set-up to about $21,000,000, for performing approximately $13,000,000 worth of work. I base my statement that it will take until December 31, 1942 to complete this work on my experience with past work of this kind. This work is being placed under contract as fast as possible, contracts are being let for the mechanical equipment which goes into this plant addition; plans are being drawn for additional final settling tanks, for an extension to the present pump and blower house, for an extension to the sludge incineration building. It will take four or five months before any plans can be
48 out for those buildings. Contracts can be let for these buildings early in 1941 but no work can start until the spring of 1941 since it is concrete construction on which work cannot be reasonably done in freezing weather. I do not believe that work can start actually on the tanks or the buildings until April 1941 and know from past experience it will take two full working seasons to do the physical work which is necessary in that program. This proposed extension of the West-Southwest

Plant has been approved by the "PWA Review Board". Practically all the construction work which the Sanitary District has done in the past six or seven years has been done under agreement with the Public Works Administration, through which the Sanitary District was able to sell $42,000,000 of its bonds and obtain in addi-
49-53 tion thereto a grant of $16,000,000, and under this agreement the Public Works Administrator appointed a Review Board to review all the plans made by the Sanitary District from January 1934 down to date.

One of the projects under the PWA Agreement just mentioned was a project which provided for certain experimental work on the West Side sewage. Since this experimentation was a PWA project, it was necessary to report results to this PWA Review Board, even though there was no PWA agreement regarding the future construction which might result therefrom. These experiments were made on several processes of sewage treatment, including chemical precipitation, activated sludge, the Guggenheim process, two filter processes, and although the experimental work was finished in 1939 the formal report showing the results of such work was not compiled until April 1940. The experimental work itself was a PWA project and the cost of experimental work was paid out of PWA funds and the PWA Review Board suggested the studies that should be made so it was necessary to report the results to this Review Board. A formal report of something like 150 pages and certain recommendations were submitted to this PWA Board in April 1940, and this PWA Review Board approved the recommendations made by the Sanitary District engineering department, regarding

this report, and recommended that the Sanitary District proceed to construct facilities for giving final treatment to West Side sewage by activated sludge, as recommended in that report.

53 I have prepared a table showing the flow in the Main Drainage Channel of the Sanitary District, yearly av-
54 erages, 1930 to 1940. These records are in the semi-annual reports made to the Supreme Court up to December 1938 and to such figures I have added figures for the other two years. These figures of flow are shown in Illinois Exhibit No. 11.

55-58 I have compiled a tabulation showing the flow in the Main Drainage Channel, by months, for the year 1939. These figures are compiled from records of flow from the Main Channel at Lockport and from other records kept by the Sanitary District in the ordinary course of business and as reported monthly to the United States District Engineer at Chicago. Such figures for flow by months during the year 1939 are shown in Illinois Exhibit No. 12.

59-60 The PWA Review Board was appointed early in April 1934 by Mr. Ickes, the Administrator of the Federal Emergency Administration of Public Works. This Review Board was appointed at that time to review plans and specifications prepared by The Sanitary District of Chicago for certain sewage treatment works and made a report to Mr. Ickes in April 1934.

The Sanitary District of Chicago in May 1934 filed a special report with the Supreme Court, indicating that the Sanitary District intended to modify the order of procedure in its sewage treatment construction program and was going to proceed at once with the con-

struction of the Southwest Sewage Treatment Works because the PWA's Review Board had so recommended and directed in its report, made to Mr. Ickes in April 1934. The Sanitary District transmitted this PWA Review Board report to the Supreme Court as a part of the special report which the Sanitary District filed with the Court in May 1934. The PWA Review Board recommended, in its report of April 1934, that instead of going ahead with complete treatment facilities for the West Side sewage at that time, the Sanitary District delay that work and study what method could best be used for secondary treatmnet of the West Side sewage and spend the funds on hand for complete treatment facilities for the Southwest sewage. The Sanitary District
61 proceeded along those lines and during the years following made certain experiments to determine the best method of supplementing the West Side treatment plant. After those experiments had been made, the Sanitary District, in April 1940, made a report to the PWA Review Board on such tests. The PWA Review Board then studied this report and recommended that the Sanitary District adopt activated sludge for secondary treatment of the West Side sewage so it was April 1940 before the PWA Review Board made a recommendation as to the type and character of treatment which should be used to supplement the existing treatment of sewage from the West Side plant.

62 Illinois Exhibit No. 13 was received in evidence. This exhibit is a tabulation of flow in the Main Drainage Channel, monthly averages for the months of January to May, inclusive, 1940.

63 The Board of Trustees of The Sanitary District of Chicago, in June 1940, approved the construction program as recommended by the PWA Review Board (in connection with the report made to it April 1940.) The Sanitary District of Chicago sold $5,000,000 of bonds June 27, 1940. The money received for these bonds can be used on the $900,000 of contract work in force and for other work now being placed under contract. One of these contracts for tightening the Government breakwater in connection with the Chicago River Con-
64 trol Works will cost around $200,000. Another contract for which bids are advertised to be received the latter part of July is a contract for additional blowers for the West-Southwest Plant. This work may cost around $500,000. The interest rate on this last bond issue of the Sanitary District was 2-½ per cent but there was a premium of $107,000 on the $5,000,000 bond issue, that is, the bonds were sold at par plus a premium of $107,-000. That money is now on deposit and with the $1,300,-000 in the construction fund as of the first of June 1940,
65-66 the resources on hand for construction are $6,300,000. The Sanitary District has something over $6,300,000 cash on hand at present, resulting from the cash on hand June 1, 1940 and the sale of $5,000,000 of bonds on June 27, 1940. In addition to that the Sanitary District had $2,400,000 of unused bonding capacity after June 27th and then the Sanitary District redeemed $3,-000,000 of bonds on the first of July 1940, bringing the unused bonding capacity up to $5,400,000. This figure in addition to the $6,300,000 cash on hand brings the total resources of the Sanitary District for construction purposes up to above $11,000,000.

67-
69 Discussion by the Master and Counsel.

70 The $5,000,000 of bonds sold by the Sanitary District, June 27, 1940, were for the following purposes:

Calumet Project	$ 150,000
North Side Project	250,000
Southwest Side Sewers	490,300
West-Southwest Sewage Treatment Works	3,909,700
Chicago River Controlling Works	200,000

The total flow from the Main Drainage Channel during June 1940 averaged 2866 c.f.s.; inflow from the Des Plaines River was 53 c.f.s.; domestic pumpage of the Chicago metropolitan area, 1662 c.f.s.; net diversion from Lake Michigan, 1161 c.f.s.

71 On May 16, 1940, The Sanitary District of Chicago filed an application with the Public Works Administration requesting that $5,598,200 be added to the resources in the existing agreement between the Sanitary District and the PWA, in order to carry out this amount of construction at the West-Southwest Sewage Treatment Plant. This application for an amendment to the present PWA agreement is still pending. The purpose of such an application to the WPA is to save money for the local taxpayers since under the PWA agreement the Sanitary District receives a grant of 30 per cent of the cost of labor and material, and under this request the PWA is asked for a total grant of $19,000,000 in place of the grant of $16,692,000 under the present PWA agreement. This would enable the Sani-
72 tary District to carry on additional construction work to the extent of this increase in the grant of $2,308,000. This report of the PWA Review Board, made April 30,

1934, to Mr. Ickes, Administrator of the Federal Emergency Administration of Public Works, was filed with the Supreme Court in May 1934, in connection with this case now under consideration.

73 Pages 15, 16, 17, 44, 45, 46 and 47 of this PWA Review Board report were received in evidence as Illinois Exhibit No. 14. Said exhibit appears in the record of these hearings, pages 73 to 83.

83-84 The supplemental report of the Sanitary District, filed with the Supreme Court of the United States, May 23, 1934, in particular page 4 of said report, was received in evidence as Illinois Exhibit No. 15. Illinois Exhibit No. 15 appears in the record of these hearings, pages 84 to 92, inclusive.

93-94 The report of the Engineering Department of The Sanitary District of Chicago, dated April 16, 1940, regarding additions to the Southwest Side Sewage Treatment Works, and also supplemental treatment for the West Side sewage, originally submitted to the Chief Engineer of The Sanitary District of Chicago, and by him transmitted to Joshua D'Esposito, Resident Projects Engineer of the Public Works Administration, and in turn, transmitted by D'Esposito to the PWA Review Board, was received in evidence as Illinois Exhibit No. 16. This report appears in the record of these proceedings, pages 95 to 110, inclusive.

111 The PWA Review Board, after studying the Sanitary District report of April 16, 1940, made a report to Joshua D'Esposito, Resident Projects Engineer, PWA, May 3, 1940, in which it was recommended that certain construction be undertaken to increase the capacity of the West-Southwest Sewage Treatment Works and to pro-

vide secondary treatment for the West Side sewage. This report of the PWA Review Board was received in evidence as Illinois Exhibit No. 17 and appears in the record of these proceedings, pages 112 to 117. The letter from Joshua D'Esposito, Resident Projects Engineer, PWA, transmitting a copy of the PWA Review Board report of May 3, 1940, to Ross A. Woodhull, President of The Sanitary District of Chicago, was received in evidence as Illinois Exhibit No. 18, and appears in the record of these proceedings, pages 118 to 119.

119-122 Certified copies of certificates from Michael J. Flynn, County Clerk of Cook County, Illinois, showing the assessed values of property in the Sanitary District for the years 1937, 1938 and 1939, were received in evidence as Illinois Exhibits No. 19-A, 19-B and 19-C, and appear on pages 119 to 122 in the record of these proceedings.

122-123 In regard to the financial status (for construction purposes) of the Sanitary District, for the years 1937, 1938 and 1939, etc., the Sanitary District had:

Date	Debt Incurring Capacity	Based on Assessed Valuation	Bonds Outstanding
Jan. 2, 1937	$119,915,555	1935	$133,322,390
Jan. 2, 1938	115,732,909	1936	124,992,890
Jan. 2, 1939	122,861,672	1937	117,484,390
Nov. 1, 1939	115,430,278	1938	114,484,390
Jan. 2, 1940	115,430,278	1938	111,489,390
May 1, 1940	121,375,552	1939	111,488,390

These figures given as of May 1st indicate that May 1940 was the first time for the past three years that the bonds outstanding were substantially less than the debt

incurring capacity. This came about because of the increase in the assessed value of the property within the Sanitary District for the year 1939, which figures became official April 15, 1940. In the years 1937 and 1938
124 the outstanding bonds either exceeded the bonding capacity or were not substantially less. In 1939 the debt incurring capacity was almost $1,000,000 more than the bonds outstanding and in 1940 this difference became about $4,000,000. These figures do not take into account contractual obligations of the Sanitary District, which amount to about $2,500,000. The figures of May 1, 1940 indicate the difference between the debt incurring ca-
125 pacity and the outstanding bonds of practically $10,000,000, and with $2,500,000 of contractual obligations that left resources available for construction of approximately $7,500,000. This figure was further increased by the retirement of $3,000,000 of bonds on July 1, 1940.
126 The permit, under which the Sanitary District diverts water from Lake Michigan, authorizes a diversion of 1500 c.f.s., annual average, from the Great Lakes-St. Lawrence watershed. This includes the run-off from the Chicago and Calumet Rivers, which amounts to approximately 500 c.f.s., annual average. This leaves about 1000 c.f.s. which can be diverted directly from Lake Michigan. In budgeting the flow, we determine at the first of each month what flow should be produced in the Main Drainage Canal for that month and in doing so set up a certain amount for so-called "storm reserve" to take care of storm water. In the month of June, 1940, we budgeted a certain amount of flow and figured there would be normal rainfall whereas in the month of June 1940, the rainfall was actually 1.31 inches, which

was about half the normal rainfall, so that in the month of June not as much as half of the storm reserve was used. If the rainfall had been normal, the flow from Lake Michigan, including the rainfall as diversion,
127 would have been about 1300 or 1400 c.f.s. The 1500 c.f.s. permitted from the Lake Michigan watershed is a net figure. The total discharge from the end of the Channel at Lockport is measured. A credit is then taken for domestic pumpage in Chicago and for inflow from the Des Plaines River and after these credits are taken, the remainder is the net diversion, which cannot be more than 1500 c.f.s., annual average. The figure of approximately 1161 c.f.s. on the tabulation for the month of June would correspond with 1461 c.f.s. for the period January 1 to May 31, 1940, shown in Illinois Exhibit No. 13. This 1161 c.f.s. would correspond to the 1698 c.f.s. for the month of May; 1437 for the month of April; 1578 for the month of March; 1228 for the month of
128-130 February; and 1364 for the month of January, all as shown on Illinois Exhibit No. 13.

The rainfall is charged as a part of this 1500 c.f.s., annual average diversion, even though it is not water directly from Lake Michigan, it is water which is tributary to Lake Michigan. It is necessary to average up by the end of the year at 1500 c.f.s., or less, but since rainfall is so uncertain sometimes we have saved up a little too much in the early part of the year. There have been other times when we haven't saved quite enough and have had to cut the flow down very low in the latter part of December to average out.

1409 When the diversion of water from Lake Michigan was reduced to 1,500 c.f.s. in January 1939, we started to budget the flow very carefully. I have prepared a tabulation showing the planned flow and the actual discharge of water from the Main Channel at Lockport
1410 for the years 1938, 1939 and 1940. This was introduced as Illinois Exhibit No. 40. On this exhibit, under the heading "Planned Flow", column one indicates the total flow as planned at the beginning of each of the years 1939 and 1940. Column two shows this flow as revised from month to month. Column three, marked "Storm Reserve", shows the estimated amount of storm run off. Column four indicates the average dry weather flow as planned. The canal is operated with a flow corresponidng to the planned average dry weather flow and this condition is not changed except when it is necessary to increase the flow to carry off storm run-off. In
1411 the table there are three columns under "Actual Flow". Column seven, "Actual Dry Weather Flow", does not differ greatly from column four, "Planned Average Dry Weather Flow". Column six, "Storm Run-off", does vary from column three, "Storm Reserve", because actual storm run-off has not followed the normal estimate in the past two years. Column five is the actual average monthly flow. In February 1939 it was planned to flow 2,400 c.f.s. of dry weather flow and 400 c.f.s. was estimated for storm reserve, making a total of 2,800 c.f.s. It can be noticed that the actual average dry weather flow, on days not affected by storm run-off, was 2,430 c.f.s. It can be noticed that actual storm

run-off was 1,559 c.f.s. so it became necessary to flow a total of 3,989 c.f.s. in that month. That was one month when the storm run-off exceeded normal. It also exceeded the normal in March 1939.

An opposite case is shown in the month of June 1940; In that month, it was planned to flow 2,800 c.f.s. dry weather flow, with an allowance of 400 c.f.s. for storm run-off, making a total flow of 3,200 c.f.s. The actual average dry weather flow was 2,746 c.f.s., not much different from the 2,800 c.f.s. planned. The storm run-
1412 off was only 130 c.f.s. instead of the 400 c.f.s. planned, so the total actual flow became only 2,876 c.f.s.

From this exhibit it can be noticed that by October 1939 the actual storm run-off had been very much less than the planned storm reserve so it was safe in October to increase the original budget of total flow from 2,900 c.f.s. to 3,100 c.f.s. Then, in November, it was increased from 2,800 c.f.s. to 2,900 c.f.s. There was no storm run-off in November and considerable storm reserve was accumulated, hence in December, it was possible to plan a total flow of 3,500 c.f.s. and the actual flow was 3,469 c.f.s.

Now, you notice in February, March, April, May, 1939, we planned an average dry weather flow of about 2400 c.f.s., and our average dry weather flow in the days not affected by storm run-off, that is, the actual flow, was 2430 c.f.s., in February, 2476 in March, 2417 in April, 2263 in May.

Now, that is about as low dry flow as is safe, when you consider that the domestic water pumpage and the inflow from the Des Plaines Valley amounts to about 1600 c.f.s., or perhaps 1650. and when you consider

that the average run-off of the Chicago and Calumet
1413 Rivers amounts to about 550 c.f.s., you have a total flow of around 2100 c.f.s., exclusive of diversion, so when we planned a flow of 2400 c.f.s., that means we planned to take only 300 c.f.s. out of Lake Michigan.

Now, the Calumet River is still open, that is, it has an open connection with Lake Michigan. The Chicago River has a so-called tight connection, on account of the Chicago River Control Works, but with this 300 c.f.s. coming in from the lake through a channel which is 20 feet deep and 200 feet wide, or 4,000 square feet, the velocity is less than a tenth of a foot a second. In other words, there is practically no slope from the lake, and it would take very little surplus water running into the river from land to reverse that flow, so we have never felt that it was safe to operate the canal with a lower dry weather flow than 2400 c.f.s.

1414 During storms there are times when water runs off the land into the Chicago and Calumet Rivers in quantities as high as 10,000 to 12,000 c.f.s. If the discharge at Lockport was not increased to draw this water from the Chicago River to Lockport, the water would flow into Lake Michigan. With the flow as at the present time, there is a slope or drop of approximately six inches between Lake Michigan and Lockport. To flow 10,000 c.f.s. through the Canal, which 10,000 c.f.s. may come from an ordinarily heavy rain, a slope of seven feet between Lake Michigan and Lockport is needed. It is obvious that if a water level at the Lockport end of the Canal was not lowered, the storm waters running into the Calumet and Chicago Rivers near the lake would raise the level of those rivers and cause flow

into the lake. This can be prevented in the case of the Chicago River because of the control works at the mouth of the River, but not in the case of the Calumet River. While in the case of the Chicago River, there is a limit. The level of the Chicago River cannot be permitted to rise too high or there would be flooding of basements in the Chicago area.

1415 In the latter part of January, I testified that the Sanitary District had 27 contracts in force, the uncompleted work on which was estimated at $212,000. Since that time, six of these contracts have been completed; ten other contracts have been let; and $518,000 has been expended. Three of the new contracts are major contracts in our future sewage treatment construction program.

Illinois Exhibit No. 41 was received in evidence. This exhibit shows profiles of the water surface in the Chicago River and Drainage Canal.

1416 It shows that in June 1940, with an average flow of 2876 c.f.s., the water surface slope dropped from 0.78 c.c.d. at the mouth of the Chicago River to -1.25 at Lockport. In other words, there was a drop of about six inches between Chicago and Lockport to produce a flow of 2876 c.f.s.

Another profile shownig a discharge of 10,140 c.f.s. on September 1, 1927, shows the water surface at the lake in Chicago at approximately the same elevation as in June 1940. In other words, it required a drop of 7.2 feet to produce a flow of 10,000 c.f.s.

The 10 contracts I mentioned before as having been recently let are a part of a supplementary construction program amounting to about $12,000,000, of which $10,-

000,000 of work is for additional complete treatment fa-
1417 cilities for the West Side sewage, to be built at the Southwest Side Plant. Of the three important contracts mentioned, one was for additional pumps at the Racine Avenue Pumping Station, to cost $90,570. Another contract was for 3 blower units at the West Southwest Sewage Treatment Works, to cost $544,300, and the other major item was a contract for making watertight the breakwater in the Chicago Harbor, which is part of the Chicago River Control Works. The contract price on this work is $119,710. The work of constructing the supplementary treatment facilities is proceeding with reasonable diligence.

1418 Illinois Exhibits Nos. 42 and 43 were received in evidence, being a record of daily discharge at Lockport, for the years 1939 and 1940, and a record of half hourly discharge at Lockport on the 15th day of each month, for the years 1939 and 1940. In these tabulations (Exhibits Nos. 42 and 43) there are certain half-hour periods where the discharge increases approximately 1600 c.f.s. over the preceding half-hour periods. One instance is in the column for January 15, 1939, at 10 P. M. This increase is probably due to lockage. A flow of about 1600 c.f.s. for half an hour is required to fill the Lockport lock. There are several places in these tables where the discharge will vary in a half hour from the preceding half hour about 1600 c.f.s., or in multiples of 1600 c.f.s., and the reason for this is the water used for lockage.

1531 As Assistant Chief Engineer of The Sanitary District of Chicago, I have a lot to do with the supervision of the engineering department and I have charge of all design work. I have very little to do with construction or with operation.

I was a witness in the previous hearings before the Special Master, now Chief Justice of the United States Supreme Court. I was also a witness in the previous hearings before Special Master Edward F. McClennen.

1532 I have assisted in the preparation of the semi-annual reports of the Sanitary District to the Supreme Court; also, assisted in the preparation of the supplemental report relative to modification in sequence of the construction program, filed with the Supreme Court May 23, 1934.

In previous testimony in these hearings, I introduced tables bringing the costs on the sewage treatment construction program up to June 1, 1940; from the figures previously reported to the Supreme Court of costs to

1533 December 1, 1938. The figures of expenditures for sewage treatment plants and facilities from 1930 through 1938 were reported in the semi-annual reports to the Supreme Court. These figures as compiled by Mr. Naujoks were: For 1930, $5,339,377; 1931, $4,686,717; 1932, $705,469; 1933, $424,801; 1934, $6,755,594; 1935, $11,214,353; 1936, $16,344,921; 1937, $14,940,266; 1938, $9,570,986; 1939, $4,177,748; a total of a little more than $74,000,000 through 1939.

Q. In the petition of the State of Illinois, page five, the statement appears: "It is estimated that the cost of

said works", meaning complete sewage treatment facilities at the West Side Works, "will not exceed $9,000,000, and the estimated time for the physical construction of said complete treatment for the West Side treatment works will be two working seasons."

1534 Q. Now, this will bring the total construction cost for the completion of the sewage treatment construction program of the Sanitary District to slightly in excess of $83,000,000?

A. The record shows that prior to April 21, 1930 the Sanitary District had spent $89,812,847.25, and I assume that the figures of $74,000,000 that you have put in are in addition to that $89,000,000.

Q. My question referred to the total cost since the entry of the decree of April 21, 1930.

A. Oh, that is approximately right, based on this statement that it is estimated that the cost of said work shall not exceed nine million, but later we put in a fairly close estimate of those works at the West Side Plant of $10,555,000.

The estimate of $10,555,000 was prepared in April 1940. The other figures (for $9,000,000) were compiled in either October or November 1939.

1535 In the 1929 hearings, we submitted a future construction program of $176,166,000.00. I would not say that we were nearly $100,000,000 off on our estimates at that time. Those estimates were made as of 1928, using 1928 costs, figuring an Imhoff tank and trickling filter plant for the West Side, figuring an Imhoff tank and trickling filter plant for the Southwest Side, together
1536 with the necessary right-of-way for the Southwest Side, and before the processes of incinerating sludge

was developed. The estimates were on the high side but I wounld not say quite as much as $50,000,000. The reasons for accomplishing this work for figures less than the estimated prices were explained in the reports to the Supreme Court. Contracts were let during the depression for about 25 per cent less than the figures we had estimated; also, we effected certain economies by developing the process of incinerating sludge. In the report to the Court of January 1, 1933, it was estimated that there would be a saving of $9,775,000 by the adop-
1537 tion of the incineration process. We saved on the construction of practically all the sewers built from 1930 on, but particularly for 1933. The amounts are all stated in the reports to the Supreme Court. In testifying before Special Master McClennen, in 1933, I introduced a chart, dated September 10, 1930, showing construction costs for the complete sewage treatment program of The Sanitary District of Chicago, from September 10, 1930 to December 31, 1938, in which the total cost
1538 was estimated at $174,043,000. In that tabulation the cost of the Chicago River control works was estimated at $4,000,000. These controlling works actually cost about $2,800,000 but this was for a different type of construction. The estimate of $4,000,000 was made in 1929 and was not changed in the table dated 1932 and introduced at the hearings in 1933.

1539 I furnished the representatives of the State of Illinois with the figure of $9,000,000 for additional work required at the West Side Plant and assisted in the preparation of the petition of the State, in which this figure was used. I testified in these hearings that the estimated additional cost of construction work at the West

Side plant after June 1, 1940 was $10,969,900. In the final semi-annual report to the Supreme Court, the estimated cost of future work on the Calumet project after December 1, 1938 was shown as $302,000. Illinois Exhibit No. 7 in these hearings shows that between December 1, 1938 and June 1, 1940, $626,869.03 was expended on this project, and Illinois Exhibit No. 9 shows that future expenditures after June 1, 1940 on the Calu-
1540 met project are estimated at $723,920. In the final semi-annual report to the Supreme Court, the future work on the North Side project, after December 1, 1938, was estimated at $290,000. Illinois Exhibit No. 7 in these hearings indicates that between December 1, 1938 and June 1940, there had been expended $235,836.16 on this project. In Illinois Exhibit No. 9, the future work after June 1, 1940 is estimated at $483,219.00. Illinois
1541 Exhibit No. 10 shows the items for which the future estimates were made.

Q. Mr. Clausen: You might shorten this record a lot, Mr. Naujoks. If it is the same identical kind of work that he estimated on then or estimated on later, then we will get somewhere, but just what he estimated back three or four years ago, that isn't in the record. This isn't cross-examination of any testimony I brought out.

The Master: I don't think he would be limited to examining this witness, who is an important officer of the Sanitary District, to matters brought out in direct examination. He might, perhaps, have to put him on for cross-examination; under the new rules he can cross-examine any officer of an opposing party freely, even if he never be directly examined, without being bound by it, so I don't think the objection that it was not

brought out in direct examination is important. I should suppose that it was proper cross-examination to show that estimates are, perhaps, not accurate. It may be unnecessary time if it is all in the reports to the Supreme Court already, and in your brief you could list
1542 those figures and these figures. After all, the figures are there and maybe we could save time by having the witness check up the figures in his answer. I thought originally when you began that it might save time to let him make the summaries now instead of having to get it out of these earlier reports, but I doubt if we are making any time. All you are questioning him about is, did you say this at that time and is it this now? You could put all of that in a brief, unless the witness would like an opportunity to explain why the figures are different. It would be desirable to let him have that opportunity to explain. That is what you are trying to do, Mr. Naujoks?

Mr. Naujoks: I have given him an opportunity to explain. He has explained or attempted to explain.

A. Oh, no; I had no chance to explain.

1543 Q. Do you wish to explain?

A. You cited the fact that there was a certain estimate as of December 1, 1938 for the Calumet Treatment Plant, and that we had expended certain money and still today there was an estimated future expenditure of $723,920. Now, $610,000 of that is for a project for taking some of the sewage from the Southwest Side area over to the Calumet Treatment Plant. It is work which could be omitted, but it probably will be desirable to do this work and take some of the load off the

Southwest Plant, and it is in my estimate of future work as of today.

On the North Side project, I have an item in here for $200,000 for Golf and Glenview sewers, which was omitted from the future work in the report to the Court in 1938 because it is so-called non-essential work. It has nothing to do with the diversion, but it is a sanitary improvement that will be carried out sometime within the next year, I expect.

1544 Another item which we deducted from the estimates of essential sewage treatment work as in the report to the Court in 1938 was something like $15,000,000 for the construction of the South Side sewers. That is not essential sewage treatment work, because it doesn't effect the diversion in any way, but it was in the original $176,000,000 program. It hasn't been done yet, but it is things such as that that make estimates of 1940 differ from estimates of 1930 or '38.

The Master: Have you a tabulation, Mr. Naujoks, of the differences in estimates?

Mr. Naujoks: Some of them, yes.

The Master: Because it would make it much easier, I think, to follow them if you had a summary of them and didn't have to construct them by reading, perhaps, 25 or 30 pages of examination.

A: This brief says, "It was estimated that the cost of said works will not exceed $9,000,000", and the estimated time—those are round figures. The actual estimate of all the items of work were made three or four months later. It came out $10,500,000. I am not surprised at that difference.

1545 I do not know the amount of air used at the North Side Sewage Treatment Works when the plant was first placed in service in 1928. I would say that an allowance of 1.25 cubic feet of air per gallon of sewage was about right as of 1926 but not as of 1940. The plant was not opened in 1926; it was placed in service in 1928 but it was designed prior to the time it was built. I do not know what the nitrates and nitrites were in the effluent from the North Side plant.

1546 The Sanitary District is redeeming bonds at the rate of about $5,000,000 per year right now and if the assessed valuations of property do not become lower, the Sanitary District will come into bonding capacity to the extent that bonds are redeemed. Right now the surplus (difference between bonding capacity and outstanding bonds) is something like $10,000,000. I do not have the figures of the amount of money available for operating purposes for the year 1939. I will get such figures for the years 1939, 1940 and 1941.

1547 I will also produce the Sanitary District Budget Report for 1939 and 1940 and an estimate of the operating revenue for 1941.

1548 Since more operating revenue, estimated at $6,000,-000 in taxes per year plus other income, was needed when the Southwest Side plant went into service, the Sanitary District of Chicago, in 1939, requested the Illinois Legislature to pass a pegged levy statute, authorizing the Sanitary District to levy corporate taxes of
1549 $6,000,000 per year. The other income results from sale of sludge converted into fertilizer, sale of power, etc. Since January, 1939, the Sanitary District has not been able to generate sufficient power for its own needs

at the Lockport Power Plant and has had to purchase additional power. In the 1940 Sanitary District budget, there was an item of $1,000,000 for the purchase of power. The Sanitary District is still under contract to fur-
1550 nish the City of Chicago with power. This is an indefinite contract as to time but it could be cancelled by either side on proper notice. The Sanitary District purchases power from the Public Service Company of Northern Illinois and uses it for its own needs and sells some to the City and the Park District.

In 1939, the Illinois Legislature passed a pegged levy statute, authorizing the Sanitary District of Chicago to levy corporate taxes of $5,500,000 for the years 1940,
1551 1941, 1942 and 1943. Then, subsequent to the passage of that Act, the Legislature amended the revenue section of the Sanitary District statute for another purpose and recited the original tax rate. This inadvertently nullified the pegged levy act. Later, in 1940, the Legislature passed an act authorizing a pegged levy of $5,000,000 for two years, 1940 and 1941. Under this act, the corporate taxes of the Sanitary District cannot be less than $5,000,000.

1552 The Master: Is the general purpose of this examination to show the resources of the Sanitary District?

Mr. Naujoks: Well, no. Among other things, yes, but there are other purposes too. One purpose is to show that they requested six million dollars which they have to have for efficient operation of the Sanitary District, and the State of Illinois cut them down to five million dollars. In other words, they are a million short on what they require for operating purposes.

The Master: Well, there is really no issue presented here as to the insufficient resources at this time. They have got abundant resources, haven't they, today, for all they are planning to do? That is the impression I received from the previous testimony, and I would like to be corrected if I am thinking wrong; but I got the impression that with the money on hand and the money
1553 which they had authority to borrow and would, from time to time, be able to borrow as they take up bonds, that they are really in a strong financial position, and the only reason they are claiming they need time is not because they haven't got money, but because they say that it is physically impossible to get these contracts let and these plants constructed. Now, I may be entirely wrong in the impressions I have up to now, but it might be useful to correct me now.

Mr. Naujoks: Yes, sir, I am going to. If the Master, please, they have sufficient money for capital expenditures for the completion and construction of the program which they have outlined and require to provide complete treatment which the Supreme Court imposes on the district and the State of Illinois in the decree of April 20, 1930, as amended, but they haven't sufficient funds for operating purposes. In other words, they can't use their bonding money for operating expenses, and for that reason we contend—are going to contend—that they aren't operating a lot of the plants as efficiently, and that one of the remedial measures would be for the State to produce more money, among other things, as Mr. Pearse testified this morning, so that they could have more air at these aeration tanks, which would give them a higher degree of B.O.D. removal.

1554 The Master: Well, has there been any testimony before me to the effect that they can't operate the plants efficiently because they haven't got enough money?

Mr. Naujoks: Yes, Mr. Pearse so testified this morning.

The Master: Well, I didn't get that impression.

Mr. Clausen: No, you didn't testify to that, did you, Mr. Pearse?

The Master: I may not have followed what he said. I didn't understand that they were making any contention that they couldn't operate effectively now for lack of money.

Mr. Naujoks: Well, we have a right to show that, if that is the fact.

The Master: No such issue is raised by the pleadings, as I recall, but I should think the first thing for you to show is that they weren't operating efficiently. Then, if they wanted to explain their failure to operate efficiently by claiming that they didn't have money enough, then you would come back and show that that was the fault of Illinois, if that needs any proof, because I would have said offhand, after the Supreme Court's decision on Mr. McClennen's report, that it is quite clear that
1555 the Supreme Court won't accept as an excuse that they haven't got enough money, because the Supreme Court said in 1935 that it was up to Illinois to give them the money; and I don't believe that the Supreme Court would seriously consider now any defense claim for relief based upon failure of money. Therefore, while I don't want to shut you off and will not in any way, I am a little cloudy in my mind as to the importance of testimony as to their financial resources, either (a)

they are adequate, as I thought they were, or (b) they are inadequate and they can't complain that they are inadequate. Either from (a) standpoint or (b) standpoint the testimnoy as to their financial resources would be immaterial.

It would be, I think, material to show that their plants aren't being efficiently operated fully, but that is not a question of financial resources as far as the fact of efficiency is concerned; that doesn't depend upon financial resources. They are either efficiently operated, or they are not, and finances would only be a reason for their being inefficiently operated, if they are inefficiently operated.

Well, you proceed. I just thought I would think aloud a little bit and perhaps help myself and perhaps help you.

1555
to
1558 The population increment for 10 years' growth (1930 to 1940) in the Calumet area used by the Sanitary District in the reports to the Supreme Court was 45.6 per cent. The population increment for the years
1559 1930 to 1940 on the North Side area is not in the record. These increments were on a statement submitted to Mr. Naujoks originally and he did not want me to use them so I left them out when I testified.

The Master: In the Sanitary District's reports to the Supreme Court, or in the statements and testimony given in previous hearings, certain estimates were made as to expected population increase in certain districts.

Mr. Naujoks: Right.

The Master: Now, those estimates are not shown by anything in the record of this hearing, or anything
1560 on file in the Supreme Court so far, is that correct?

Mr. Naujoks: I believe that is right. That is correct.

The Master: They are not on file so far.

Mr. Naujoks: Let me explain it this way: The actual figures reported to the Supreme Court for the future, for the ten-year period 1930 to 1940, as to population growth by districts in the Sanitary District, have been filed with the Supreme Court.

The figures I wish to put in the record now are the percentage population increase which are not in the record anywhere as percentages.

The Master: Well, could they not be figured out by anyone who read the figures that are in the record? I mean, couldn't I see myself what percentages there were if I took the time to figure them out?

Mr. Naujoks: That is right. It would take time.

The Master: Couldn't you figure it out for me in a brief and I could ask opposing counsel to admit either that they were right or say where they were wrong. That, I think, would save us time, because if your basic figures are in the record already and this is just a mat-
1561 ter of calculation from that, you could do the calculating in your brief and make your argument upon it, and, of course, I can take judicial notice of the 1940 census figures and you can put them in your brief, and then your opponents will either have to challenge the correctness of your figures or admit them. If they challenge the correctness of them, I suppose I would have to figure them out myself, anyhow.

Mr. Naujoks: I thought it would be simpler to put them in this way and then we would have them.

A: I would rather put these figures in from my own census estimates, the ones I have been working from. I think they are right.

Mr. Naujoks: We can get together on this.

A: Suppose I tabulate the thing.

The Master: Your purpose, I take it, is to show that they assume that there would be increases in the population which the last census would show has not taken place.

Mr. Naujoks: Yes, that is right. Now, that has an effect, among other things, upon—

The Master: Upon the program.

Mr. Naujoks: Upon the remedial measures, too; upon the amount that they can treat, and things of that type.

1562 In the semi-annual report to the Supreme Court, the percentage of sewage treatment at the North Side and Calumet plants used in the tables in those reports was given as 85 per cent. This 85 per cent was an estimate of the treatment of the total sewage on the whole area on an annual average basis, although on the sewage actually going through the North Side Plant the treatment was better than 90 per cent. The percentage of sewage treatment used for the West Side plant in the 1563 reports to the Court was 33 per cent although the sewage that actually passed through the West Side plant was treated to an extent better than 50 per cent (actually 53 per cent). I cannot make a close estimate of the amount of sewage from the West Side area which was untreated during 1939. The relation

between the 53 per cent and the 33 per cent was my best estimate. The sewage that was untreated on the North Side and Calumet areas through the years to 1938 was that sewage which might be termed street wash and waste not carried to the treatment plants, and, also, some sewage which was not intercepted on those areas.

1564 The difference between the 85 per cent used in the reports to the Court and the 90 per cent actual treatment of the sewage which went through the plants was intended to cover the storm flow of sewage and other sewage which got into the channels untreated. None of the wastes of the Corn Products Company passed through a treatment plant of the Sanitary District,

1565 but the process under which these wastes were reclaimed was discovered by Sanitary District chemists while experimenting on a method to treat the Corn Products wastes. In the reports to the Supreme Court, the statement was made that these wastes have been greatly reduced as a result of certain experimental work initiated by the Sanitary District. The reports to the Court do not show that the Sanitary District treated those wastes but that there was a reduction in the amount of Corn Products wastes. In the petition to the Supreme Court, filed by the State of Illinois, in 1940, the percentage of treatment estimated for the

1566 North Side, Calumet and Southwest Side plants was estimated at 85 per cent and the population estimates were based on the 1930 census.

1567 The maximum figure of 7,325 c.f.s. shown for discharge from the Lockport Power House at four o'clock on February 15, 1939, is about 1,600 c.f.s. higher than

any other figure on that chart and is apparently due to the filling of the lock during that half hour. Other differences on this chart (Illinois Exhibit No. 43) are not so great. We set a certain figure for the average low water flow and the half hourly figures vary from that average if there happens to be a lockage, although a lockage does not change the daily average very much. The figures also vary if there happens to be a necessity to run off storm flow. We allow something like a 10 per cent variation between maximum and minimum, or between night and day flow, for the convenience of
1568 the operators at the Lockport Power Plant. The variation in the record of March 15, 1939 appears to me as if it was caused by rainfall run-off. The variation between 1,900 c.f.s. and 3,200 c.f.s. on January 15, 1939 was probably to obtain more power during the night hours. The one night reading 4,800 c.f.s., though, was obviously caused by a lockage. The heavy flows during March must have been due to run-off of precipitation.

HORACE P. RAMEY—Cross Examination.

1571 Mr. Clausen: The Sanitary District of Chicago is authorized by statute to levy an annual corporate (operating) tax of fifteen cents (15c) on each one hundred dollars of assessed valuation of the taxable property within its corporate limits. (Chap. 42, Sec. 12, Para. 332, page 1335, Illinois Revised Statutes 1939, State Bar Assn. Ed.)

The assessed valuation of the property within the Sanitary District declined from approximately $4,400,000,000 in 1928 to approximately $2,400,000,000 in 1939, so that the corporate tax levied in 1928 of approximately $6,500,000 declined to approximately $3,800,000 in 1939.

1572 In view of the increased operating cost due to bringing into operation new treatment facilities, the regular session of the 61st General Assembly in 1939 amended the Sanitary District Act and authorized the Sanitary District to levy a tax not to exceed $5,500,000 for corporate purposes for the years 1940 to 1943, inclusive. This was known as the "Pegged Levy Act".

Unfortunately, at the same session of the legislature, that is, in 1939, at the closing day, after the passage of the Pegged Levy Act, the legislature again amended the same section of the Sanitary District Act for other purposes and inadvertently omitted reference to the pegged levy provisions, and this wasn't discovered until after adjournment. Our Supreme Court has held that the last amendment controlled, so it nullified the pegged levy provisions so that the Sanitary District was again restricted to the fifteen-cent rate, which would probably reduce it to about $3,600,000.

The Governor of Illinois called a special session of the legislature to correct this situation, to meet on April 30, 1940, and limited the call to such purpose, to a pegged levy of $5,000,000 for the years 1940 to 1943, inclusive. House Bill No. 19, accordingly, was presented to the General Assembly with an emergency clause
1573 and was passed by both houses and approved by the Governor on May 31, 1940, as found in the Illinois

Revised Statutes, 1940 Supplement State Bar Association Edition, Chapter 43, Paragraph 332, page 23.

The Master: Mr. Clausen, how did the assessments go down by years prior to '39? Have you got information, or could you have that made up for me? You stated that the assessments went down from $4,400,000,000 in 1928 to $2,400,000,000 in 1939, and I would like, if possible, to have a statement of the assessments by years from '28 to '39, to show whether this decline had not taken place, to some extent at least, in the years prior to '39.

Mr. Clausen: Oh, yes. I will furnish that. That was during the depression period.

The Master: It was a gradual decline, I imagine. If you have the file—

Mr. Clausen: Yes.

Mr. Naujoks: If the Master please, I think the record should also show that the valuations as given here are not at the true value, but that they are debased to 37 per cent in accordance with the rule adopted by the local assessors and the Board of Equalization.

The Master: All assessments in this area are based
1574 upon 30 per cent of full value?

Mr. Naujoks: They are bebased to that figure.

Mr. Clausen: I think I can put in those assessed valuations by the County Clerk. Remember those certified copies, whatever it was. I will put them in as exhibits.

Mr. Naujoks: Yes, but I just wanted the records to show those were the debased figures, not the true value.

The Master: Approved by the State Board of Equalization.

Mr. Naujoks: That is right.

The Master: Which is authorized by law to fix the true valuations of which assessments shall be made, is that correct?

Mr. Naujoks: I am not certain we will agree with that. At any rate, the Board of Equalization approves it.

The Master: I assume there must be a legal basis for it.

Mr. Clausen: There is.

Q: Mr. Ramey, will you explain the differences in your estimates of construction cost as presented to the Special Master in these cases in 1929 and again in 1933, and the figures on cost of work completed and
1575 estimates of cost for future work as presented by you at the present hearings?

A: In the hearings in 1929, certain estimates were presented to the court, and on those figures the condition of the construction program on April 21, 1930, was as follows:

Work completed	$ 81,917,603
Work under contract	11,473,683
Future work	176,166,000
Total:	$269,557,286

That was the total program.

In the report to the Supreme Court of January 1, 1933, page 11, the statement was made:

"In the semi-annual report to the Court of January 1, 1932, pages 9 to 10, attention was called to

the fact that contracts were being let at prices far below those estimated in the program submitted to the Supreme Court. The total saving in this respect to date has amounted to $5,330,000. That on some twenty contracts, works estimated in the original program to cost $19,834,000, had been let for $14,514,000. This has been due in large measure to contracts being let during the business depression. A part of it is due to the inevitable change in plan certain to happen in a project of this magnitude.

"In order that the work already accomplished may appear more accurately in relation to the future work to be done, a revised estimate is sub-
1576 mitted herewith in which proper account has been taken of reasonably reduced construction cost which probably will prevail up to the end of 1938, and in which more definite information as to the amount of sewage to be treated at the various plants has been given due consideration."

As a result of that, the total of $14,662,375 was subtracted from the total program, that figure being made up of the $5,330,000 of savings on contracts let and $9,332,375 reduction by re-estimate.

In the report to the Supreme Court of July 1, 1933, page 2, the statement was made that because of the adoption of the incineration process the figure of $9,775,000 was eliminated. An amount of $6,000,000 was eliminated from the estimate for miscellaneous plants and sewers. That appears on page 3 of this same report of July 1, 1933.

On page 11 of the report to the Supreme Court of
1577 July 1, 1933, a total of $17,000,000 is eliminated from

the program because of the combination of the West Side and Southwest Side Plants on the one area, and on that same page a reduction of $965,844 because of re-estimate of the program. These figures make a total of $33,740,844 eliminated as reported to the court on July 1, 1933.

In the report to the Supreme Court of January 1, 1935, page 13, because the PWA Review Board had recommended that the Southwest Intercepting Sewer and the Southwest Treatment Plant be built at less capacity than had been originally estimated, a figure of $7,525,000 was eliminated.

In the report to the Supreme Court of July 1, 1935, page 11, an item of $2,463,000 is eliminated because of savings on contracts let, and a figure of $1,073,000 eliminated by a re-estimate of the program. Those two figures total $3,536,000 eliminated in the report of July 1, 1935.

In the report to the court of January 1, 1936, page 16, is this statement:

"After the execution of the latest agreement with the Public Works Administration dated September
1578 21, 1935, estimates on the entire future construction program were revised and reduced by $7,736,000. The principal items entering into this reduction were $1,500,000 of contingency items eliminated from estimates on Calumet and West Side Treatment Plants; $4,636,000 taken from the West-Southwest Treatment Plant estimate, figuring ultimate capacity at 1,000 m.g.d. instead of 1,200 m.g.d. as previously done: also for omission of power recovery plant; $701,000 saved on letting of contracts one and four of the Southwest Side

Intercepting Sewer, and $499,000 cut from the estimate of cost of the proposed South Side Sewers."

In the report to the Supreme Court of July 1, 1936, page 10, there is a reduction in the program of $401,000 because of re-estimating.

In the report to the Supreme Court of July 1, 1937, page 9, there is a reduction in the estimate of future work of $1,514,000, the major part of which is made up of an item of $950,000 eliminated from the estimate of miscellaneous plants and sewers.

In the report to the Supreme Court of July 1, 1937, pages 10 and 11, is this statement:

"At this time, eighteen months in advance of the
1579 date of the ultimate reduction in the diversion of water from Lake Michigan under the decree of the court of April 21, 1930, it is proper to submit a revised estimate of the cost of the essential construction work remaining to be performed. The original program outlined in 1938 contained many items which have been materially altered during the course of the past nine years. It also contained some items which, in the light of present-day knowledge of the art of sewage treatment and of the growth of the community, could have been omitted.

"In 1928, near the close of an era of prosperity and a period of rapid growth of the community, certain items were included as essential items which now are known to be not essential. This change in conditions has been brought about partly by natural causes and partly because of the recent prolonged depression. Items were included for a number of sewers in outlying sections suburban

to Chicago which are not yet necessary and probably will not be needed till after 1940, because there has been little building in these communities for the past six years, and there is no prospect for a revival of building in the near future. For this reason the following sewers can now be eliminated from the program:

"The Calumet area, the Westerly Section of the
1580 Blue Island Intercepting Sewer, $510,000; California Avenue-Oak Forest Sewer, $1,000,000; the Evergreen Park Sewer, $580,000.

"On the North Side: the Howard Street Sewer, $2,000,000; the North Shore Intercepting Sewer, $550,000. Those figures total $4,640,000;

"The extension of the North Side Sewage Treatment Plant, estimated to cost $1,200,000, probably will not be required until 1945 or later. The lessening of the period of detention of the sewage in the tanks for aeration has greatly increased the capacity of this portion of the plant. Thus, with the addition of more final settling tanks now under construction, this plant will have sufficient capacity for the next few years.

"The contingent item for miscellaneous plants and sewers reduced to a million dollars at the time of the last semi-annual report to the court can now be eliminated. The item of $15,000,000 for South Side sewers and an item of $1,100,000 for that portion of the Racine Avenue Pumping Station required to handle the discharge of these sewers must be deferred until some future time because of financial necessity. The postponement
1581 of this work will not affect the reduction in diverl sion of water from Lake Michigan. The proposed new South Side Sewers comprise a very important sanitary improvement, but their construction

would not bring any additional sewage under treatment. The items eliminated from the program of essential construction work at this time and postponed until some future date have been estimated to cost $22,940,000."

In a subsequent report to the Court of July 1, 1938, page 7, it can be noticed that the construction program was reduced $380,000 by re-estimate; and on January 1, 1939, page 9, of the report to the Supreme Court, a similar reduction of $2,497,000.

All these reductions mentioned total $94,932,219. Subtracting that figure from the total as submitted at the 1928 hearings leaves a total on January 1, 1939 of $174,625,000. In the report to the Supreme Court of January 1, 1939, the total program figures $174,255,000, a difference of $370,000, which has apparently been lost somewhere in my rough check-up of these estimates.

Now, yesterday I was asked why the Calumet project when reported to the court January 1, 1939, that there was $302,000 of future work, and in these hearings we stated that between December 1, 1938 and
1582 June 1, 1930 we had spent $626,869, or $324,869 more than the estimated future work as reported to the court on January 1, 1939, and reported the future work as of June 1, 1940 was $723,920, or a total of $1,048,789 added to the program.

The explanation for that is that some of the items which were eliminated, or deferred, as mentioned in the report to the court of July 1, 1937, have now been replaced. We are undertaking to do some of those items. Most of them as WPA projects. The Calumet project, for instance—one item which was deferred was

the Evergreen Park sewer. We have been doing that. Also, a part of that contingent item of $1,500,000 on the Calumet Treatment Plant and West Side Treatment Plant—several items of work on that plant are now being done as WPA projects. The same statement can apply to the North Side Treatment Works.

In the report to the court of 1937 we took $2,000,000 out of the estimate because of a postponement of construction of the Howard Street Sewer. We now plan to build a portion of that sewer. This portion is known as the Golf and Glen View Sewers. That is $200,000 worth of work as submitted in these hearings. Also certain of the additions to the North Side Plant which we had planned in 1937 to defer because of financial
1583 needs, we are now doing as WPA projects.

Another question was asked about why we furnished the representatives of the State with a figure of $9,000,000 for the extension of the West Side Plant in November, 1939, and in April, 1940 gave an estimate for $10,550,000 plus.

Well, one item that is in the April, 1940 figures and not in the November, 1939 figures is $440,000 for fertilizer plant; and the other difference is made up because of a detailed estimate made on the sludge drying plant which we didn't have back in 1939. That figure of $9,000,000 was a round preliminary estimate.

The difference between the figures compiled in November, 1939 and April, 1940 would not be $1,580,000 but would be $1,980,000, because the estimate for the
1584 fertilizer plant is in the figure of $10,554,900. The figure for total future contracts is $10,554,900. The total for the 10 contracts in force is $415,000, the grant

total being $10,969,900. Of the figure of approximately $74,000,000, spent on the construction program from April 21, 1930 to the end of 1939, all of the funds were
1585 furnished by The Sanitary District of Chicago, except $16,692,000, which came as a grant from the Public Works Administration.

Referring to Illinois Exhibit 43, entitled: "Main Channel Half Hour Discharge at Lockport on the 15th Day of Each Month for the Year 1939," the figures for flow include the water which goes through the wheels of the Lockport Power House; includes lockage, leakage, flow over the dam, and, also, about 35 c.f.s. which is taken from the Canal above Lockport by the Texas Company, and some other industrial plants and returned to the Canal below the Power House. Approximately 90 per cent, or a trifle more, of the total flow is passed through the water wheels of the Lockport Power House.

1586 The difference in flow between the daylight hours and during the night hours is due to the power generation at night but the variation between day flow and the night flow is not 100 per cent. The changes in flow during certain hours of the day indicate that the flow is varied for power purposes but other things are more important than power. Whenever it is necessary to run
1587 off flood water, this takes precedence; also, lockage takes precedence over power. In July, 1940, for instance, there is not very much difference. Right now we are operating with a flow around 2,800 c.f.s. average low flow and we permit the operators at the Power House to increase the flow to 3300 or 3400 c.f.s. during the night.

Referring to January 15, 1939, at 9:30 P. M. on Exhibit No. 43, the discharge is 3259 c.f.s.; at 10:30 P. M., the figure is 4852 c.f.s. This difference represents water
1588 used for lockage. Then from 10:30 P. M. to 6:30 A. M., the flow averaged 3270 c.f.s., and during the day hours thereafter, the average was approximately 1900 c.f.s. The reason for that was that 1900 c.f.s. was used for generation of power throughout the day and 3200 c.f.s. throughout the night.

1589 The Sanitary District of Chicago owns and operates the Lockport Power House. There are seven water turbines installed in this plant; five of these turbines will use 1667 c.f.s. each; then, there are two new units which will use more water but offhand, I don't recall the maximum discharge capacity of those units. I will check this up and furnish the figures. The total discharge capacity of all the units in the power house is well above 10,000 c.f.s. If the diversion should be increased to 5000 c.f.s., a goodly portion of the additional 3500 c.f.s. would run through the water wheels at Lockport and be used for the development of power.

1590 In 1938 the power generated at Lockport was about 130,000,000 kilowatt hours; in 1939 it was about 70,000,000 kilowatt hours; that power is worth about .5 of a cent per kilowatt hour.

1591 The figures on Illinois Exhibit No. 42 are figures of discharge from the end of the Channel at Lockport, and as an average they will represent flow through the channel, but the flow can be stopped absolutely at Lockport for a few minutes without interfering with the flow of the Chicago River. Where a minimum discharge of 456 c.f.s. is shown on this exhibit as a half-

hour reading of discharge, the low reading is probably due to the fact that the transmission line from the power house had failed, or something of that nature. These figures of discharge from the end of the Channel represent flow through the Channel only as averages of long periods of time. In these figures can be found maximum discharges as high as 19,000 c.f.s. yet it is a physical impossibility to flow that amount of water through the channel.

1592 It would be unsafe to reduce the flow in the Chicago River to 323 c.f.s. at any time but it would not be unsafe to reduce the instantaneous discharge at Lockport to such a figure for only a few minutes.

In Illinois Exhibit No. 9, the estimated expenditure on the Chicago River Controlling Works was listed at $200,000. A contract for this work was awarded for $119,710. The construction will cost $15,000 or $20,000 more than this because of engineering costs and other overhead. The engineer's estimate on this contract was about $160,000 and the low bid was $119,710.

1593 As of December 1, 1938, the available funds of the Sanitary District unpledged for construction costs was a very small amount. On January 2, 1939, the Sanitary District had a debt incurring capacity of $122,-961,672; outstanding bonds amounted to $117,484,390. There is a difference of about $5,000,000 in these figures but the contract obligations were approximately $3,-000,000 so that left about $2,000,000 of debt incurring capacity. At that time, the Sanitary District did not have sufficient funds to complete the entire construction program.

In the report to the Supreme Court of January 1, 1939, on page 9, the future work was estimated at $14,000,000; the cash on hand in the PWA accounts was $3,700,000, leaving essential work to the extent of more than $10,000,000 to be financed from other sources and the Sanitary District then had about $3,000,000 resources for this.

1594 The State of Illinois did not contribute any money towards the construction of works by the Sanitary District. The Sanitary District did not make application to the State of Illinois to provide such funds.

The population equivalent of the Corn Products wastes was included in all the tables referring to actual sewage treatment in service in the semi-annual reports of the Sanitary District to the Supreme Court.

1595 The change in flow through the Drainage Canal from daylight hours to night hours changes the slope in the Canal very slightly, something like an inch and a half, or possibly 2 inches. It is certainly not a fact that this difference would be measured in feet and not in inches.

1595

1596 In the reports to the Court, copies of which were furnished to representatives of the complainant lake states, the exact status of the sewage treatment construction program was reported, and it must have been obvious from those reports that the program as contemplated at the time of the decree of the Court would not be completed in its entirety by December 1, 1938.

No particular reference was made to the statement in the supplementary report to the Court on May 23, 1940, page 6, "The defendants further respectfully represent

that this change in the sequence of procedure recommended by the Engineering Board of Review and by the defendants will not retard but, in the opinion of the defendants and in that of the Engineering Board of Review, will improve conditions and expedite the performance of the decree". This is a true statement because the change in sequence of procedure did actually expedite the work and more work was done because of that change than would have been done if the change had not been made.

1597 As the difference between "would expedite the work", and "would expedite the performance of the decree", I assume that the construction of these works was in performance of the decree.

1598 One place where it should have been obvious to the Court or to the opposing lake states that the Sanitary District would not be able to fully complete the sewage treatment construction program by 1938 is in the report to the Court of January 1, 1937, page 9, where there is an estimate of $64,000,000 of future work, and this paragraph:

> "Funds remaining unexpended from the amounts obtained under the agreement of September 21, 1935 with the Federal Emergency Administration of Public Works are definitely allocated to projects in this future work estimated to cost $23,445,000. Approximately $2,500,000 of funds obtained from
1599 the P. W. A. are not now definitely allocated but may be used for some of this future work. This leaves work estimated at $38,213,000 to be financed from other sources."

and at that time the Sanitary District had no funds for construction work. I think it should have been apparent to the Court and to the opposing lake states that the entire sewage treatment construction program couldn't then be completed in accordance with the Supreme Court decree, as amended.

We did not at that time make any request of the State of Illinois to furnish the funds. We were doing all the work which was physically possible for an organization such as the Sanitary District to do. We were doing construction work at that time at the rate of about $15,000,000 per year. I do not know what the resources of the State of Illinois were at that period.

Q: Now, Mr. Ramey, when was the decision made
1600 not to complete the West Side Sewage Treatment Plant in accordance with the decree, and by whom was that decision made?

The Master: I would like to ask counsel if the Supreme Court hasn't in effect decided that no adequate excuse has been shown by the State of Illinois for not completing these works, and I would also like to ask counsel if the order of reference to me does not extend to any inquiry on that subject.

Mr. Clausen: Not only that, the decree doesn't provide anything with respect to construction work.

The Master: It is simply provided that the diversion should be cut down to the rates indicated.

Mr. Clausen: That is right.

The Master: Now, as I read the opinion of the Supreme Court last April, it is a finding, a declaration by the Supreme Court that no adequate excuse has been shown by the State of Illinois, and in the reference

to me there is no provision that I should consider testimony as to whether there was an adequate excuse or whether there was not, and whether more money should have been provided or whether it should not, whether the Sanitary District should have been able to carry on a larger program than it did or whether it should not. There is nothing in the order of refer-
1601 ence that I see that directs me to inquire into those matters, and my impression would have been that the Supreme Court has reached a determination already that no adequate excuse has been shown and that the only point left open to me is, as stated in the order of reference, whether there is any menace to health, and, if so, what could be done about it. I may be mistaken in my impressions. As I have repeatedly said, I don't want to shut counsel off from any proof they desire to make, within very broad limits, but if counsel for Illinois themselves do not take exceptions to the view that I have stated, I should not think that counsel for the opposing states would undertake to extend the scope of the inquiry.

Mr. Cohan: Just as a matter of record, doesn't the record as it stands now contain a voluminous amount of facts and figures put in by the State of Illinois?

The Master: Yes, I think it does. No objection, I think, however, was made to the introduction of those facts and figures.

Mr. Cohan: I am not quite sure about that. I think at the very beginning there was.

The Master: There was a general reservation.

Mr. Naujoks: That is right. We agreed to reserve our objections and later go over the transcript and file
1602 formal motions to strike and so forth.

Mr. Clausen: I might say a lot of that was furnished at your request, however.

Mr. Wallenstein: Not only that, it goes to the question of whether or not there could be any other ameliorating means or remedies to clear this condition, the third point in your order of reference.

The Master: Well, proceed, gentlemen.

The amount of rainfall necessary to cause storm water in sewers of the Sanitary District to by-pass to the Sanitary Canal depends on circumstances. Most of the sewers are designed to handle 50 per cent in excess of the 1960 dry weather flow. That means actually that they will carry about twice the average dry weather flow as of today, but some of the sewers, in particular, those near the River in the Loop district, are designed to take twice the dry weather flow. They will take all the storm flow except that from major storms. A lot depends on the condition of the ground and on how the rain falls. If the ground is frozen and there is ice on the ground and a warm rain occurs in
1603 the winter, the sewers will by-pass to the River with very little rainfall. With a dry summer condition, much more rainfall is required. The average concentration time of the average drainage area in Chicago is about three hours, but the concentration tim in the Loop district is about 20 minutes. I do not know how many hours a year on an average storm water will overflow from the sewers into the Chicago River.

1604 Mr. Pearse can give better information with reference to the untreated or partially treated sewage from the Indiana communities which finds its way into the Calumet River.

I am not familiar with the use of chlorine as an agency for the prevention or reduction of odors and for sterilizing bacteria.

We provided aeration chambers, or cascades, at the outfall sewer of the Southwest Side Plant to introduce additional oxygen into the effluent. I believe that similar cascades were provided at certain places in the
1605 North Side Plant for the same purpose. The purpose of this is to help stabilize the B.O.D. in the effluent which is discharged into the Canal. If water is flower over the dam it would pick up more oxygen than if it flows through water wheels. Water passing through water wheels has not as much chance of picking up oxygen as it has if flowing over an open dam. Flow
1606 over an open dam would add some oxygen to the water. I have made no figures on the amount of oxygen which could be introduced into water at Lockport if this water was passed over aeration cascades. A large percentage of the dry weather flow from the West Side Imhoff tanks could be put through the Southwest Treatment Plant for a short detention period. This should reduce the B.O.D. in the effluent which is discharged into the Canal. We have made some figures along this line. It would take about a year to construct a sewer between these plants to effect such treatment. No contracts have been let for such a sewer but preliminary plans have been drawn.

1607 All the contracts for the completion of the West-Southwest project have not been let. The plans and specifications have not all been drawn. We are working on them. We plan to build the same type of aeration tanks that are now in service at the Southwest Side Plant and possibly the same type of final settling tanks. We have let contracts for three blowers with a much larger capacity than the present blowers. The new sludge drying plant will not be much different from the plant now in service, although many things in it will be modified but there will be no entirely new
1608 idea in this plant. We are planning the construction of the additional facilities in a manner to prevent any interruption in the operating of the present facilities.

There was a break down due to the cracking of a pipe in the sludge line from the North Side Treatment Works to the Southwest Side Treatment Plant on July 6, 1940. This happened on Saturday morning and was not fixed until late Monday.

If all of the sludge of the Sanitary District not made into fertilizer or placed on spoil banks should be disposed of on land, it would ameliorate conditions in the Canal but it would make a mess somewhere else wherever that sludge was lagooned.

1609 Dr. Mohlman can give better information than I can regarding the chlorinating of sludge in order to prevent odors.

The budget report of the Sanitary District for 1940, referring to the Glenview Sewage Treatment Works, states: "During the warm months the practice of chlorinating the Imhoff tank effluent before application to the trickling filters to prevent odors was continued".

This same budget report, with reference to the Morton Grove Plant, states: "The Imhoff tank effluent was chlorinated during the warm months to prevent odor nuisance".

1610 At the Southwest Sewage Treatment Works, the effluent that is used for condensing purposes is chlorinated to prevent the growth of algae in our condenser tubes.

The largest amount of sewage flow from the West Side area which has been put through the Southwest Side Plant for treatment appears in the monthly records of operation of this plant.

I have not read the letter of Dr. Buswell, regarding chemical process for supplemental treatment at the West Side Treatment Works and have no comment to make on it. I presume his statement was considered by the PWA Review Board.

1611

1612 The report prepared in the Engineering Department of the Sanitary District in April 1940 and submitted to the PWA Review Board states, on page 9: that the effluent from an Imhoff tank plant had a B.O.D. of 57 and that the effluent from Imhoff tanks plus chemical precipitation had a B.O.D. of 36 and that the effluent from

1613 an activated sludge plant had a B.O.D. of 10. If the B.O.D. in the effluent from the West Side Works should be reduced from the present 57 to 36 by the addition of chemical treatment this would ameliorate conditions in the Sanitary Canal and Brandon Road Pool but it would not ameliorate conditions as much as installing activated sludge and reducing the B.O.D. to 10. I do not know about the other communities, state institu-

tions and industries above Joliet contributing to conditions in the Canal and Brandon Road Pool. Dr. Mohlman has testified to these things.

1614 I stated that preliminary plans had been prepared for the sewer from the West Side Plant to the Southwest Side Plant. The approximate size of this sewer has been determined but detail contract plans have not yet been started. We expect to get started on these detail plans so that contracts can be let during the coming winter so that this sewer could be
1615 completed by the fall of 1941. I don't recall the estimated cost of this sewer offhand. It is in the neighborhood of $400,000. It is included in the item "Conduits, Tunnels," etc., for future contracts under the West-Southwest Side Sewage Treatment Plant, totaling $757,600.

If at the Southwest Side Plant the water now used through the condensers should be passed over cascade areas directly into the Canal the result would be to stop the operation of the blower plant and generator plant. The use of municipal water for condensing purposes would be too expensive. The use of water from the Canal for this purpose would require the construction of a large pumping plant. This would be physically possible but not feasible.

1616 The effluent from the Southwest Side Treatment Plant is used for condensing purposes. It is flowed by gravity through the condensers and to the Canal. If Canal water were used, it would be necessary to pump that water from the Canal up in order to force it through the condensers. The use of water from the municipal water supply would be very costly.

All these things were considered when the Southwest Side Plant was designed.

It would be possible to construct a sewer from the West Side Plant to the Southwest Side Plant by the summer of 1941 but this might slow up some other things which are more important.

1617 The present capacity of the Southwest Plant is large enough to care for a considerable portion of the dry weather flow of the West Side Works. This connecting sewer is a part of our ultimate plans.

It has not yet been definitely decided whether the effluent from the West Side Plant will be run into the present aeration tanks or into the new battery of aeration tanks, which is to be constructed.

If the Brandon Road Pool were restored to the condition that existed prior to 1933, that is, if the rapid section of the Des Plaines River were restored, the water would be re-aerated more than at present.

1618 It would also be re-aerated flowing over the Jackson Street dam, which, of course, would have to be rebuilt.

Dr. Mohlman can answer much better than I can both as to the effect and the cost of chlorinating the effluent of all the sewage treatment plants. Such chlorination of treatment plant effluent would probably ameliorate conditions in the Canal and Brandon Road Pool.

If the entire water supply of the City of Chicago should be metered, no doubt the water use would be reduced. That would have the effect of increasing the pumping capacity and the aeration tank capacity of the sewage treatment plants. It would have no effect

whatever on the sludge handling capacity because the same amount of solids would be in the sewage in any case.

1619 The water for domestic use is pumped directly from Lake Michigan. The City of Chicago can take any amount of this water it desires. The only incentive to be economical in the use of water is the cost of pumping it. I think about 60 to 70 per cent of the water is metered but Mr. Pearse will furnish figures on this matter. As I understand it, all the water used by industries, hotels, and apartment buildings is metered, but there is a considerable area in the residential
1620 districts where there are no meters ,as yet. If metering were made universal, it would reduce the amount of water taken out of Lake Michigan for domestic purposes. This would not increase the amount of water available for the waterway. The Sanitary District can divert 1500 c.f.s. annual average from the Lake Michigan watershed, exclusive of domestic pumpage. Any domestic pumpage is in addition to this 1500 c.f.s. The reduction in the quantity of domestic pumpage would result in a little more treatment plant capacity, a little more detention time in the aeration tanks, but I
1621 think the effect would be very slight. It would also increase the capacity of the sewers. Chicago uses a larger amount of water than any other City its size. It uses a considerable amount of water per capita, more per capita than Milwaukee. I think the figure for Chicago is about 250 gallons per capita per day. If all the City water in Chicago should be metered, this would reduce the amount of water going through the Lockport Power Plant slightly.

1622 It would be possible to provide aeration cascades at Lockport or other places in the Sanitary Canal but I don't know as to the feasibility of this. There are ways of adding oxygen, that is either air or oxygen, without cascades. One way is in the manner in which air is added to the aeration tanks, that is to blow air into the water. A cascade is a little waterfall.

1623 If all the sources of pollution above Joliet, including the various communities, state institutions, private industries, and the Sanitary District of Chicago, were eliminated by having all raw sewage treated locally, this would ameliorate conditions in the Brandon Road Pool.

It would be possible to shut down the water wheels at Lockport and provide cascades without interfering with navigation. The construction of such cascades would probably cost more than introducing oxygen into the water in some other manner. I have not estimated the cost of such construction for use over

1624 a 2-year period. If it should be intended to construct such cascades and destroy the power plant, it might be cheaper to aerate the water in some other fashion, by blowing air through it for instance. There are no facilities for such procedure at present. Cascades could be built along the Des Plaines River near the present Stony Sluice Gates but at that point there is available less than 10 feet of fall compared to the

1625 38 feet of fall at the Lockport Power House. I do not know what the cost would be for the construction of a cascade at the Stony Sluice Gates near Lock-

1626 port. If details are furnished of what is desired in

the way of cascades, I will make an estimate of cost of constructing same.

The two new generators were installed in the Power House at Lockport about 1935; one of them is used regularly; sometimes two are used; in addition there are five old units in this plant.

HORACE P. RAMEY—Cross Examination.

1803-1805 Mr. Naujoks requested Ramey to figure the elapsed time for flow down the Sanitary Canal from Damen Avenue to Summit, then to Lockport, and then to Brandon Road Pool, under conditions as of January 1939, with a flow of 2911 c.f.s.; also, with a flow of 4227 c.f.s., under average conditions as existing in June 1939; also, 7891 c.f.s., under conditions as of January 1939.

Q: * * * * and also figure out the elapsed time of flow down the canal and waterway through Brandon Road Pool for each of the distances from Damen Avenue to Summit, second, from Summit to Lockport, and, 1806 third, from Lockport to the outlet of the Brandon Road Pool, with a flow of 19,064 cubic second feet under average conditions existing in June, 1939?

A: You mean, 19064?

Q: Right. That is the maximum flow during that time.

A. Well, that can't be done. You can't flow that quantity through the waterway.

Q: Well, whatever the flow was down the canal.

A: Well, the flow through the canal —

Q: Under the maximum conditions, so that where you had a flow of 19,064 at Lockport—

A: This table indicates that there was a discharge from the end of the canal at Lockport of 19,064 cubic feet per second.

Q: Yes.

A: That doesn't indicate that there was a flow of that much through the drainage canal.

Q: Not all the way through, that is correct.

A: Because it is impossible.

Q: That is right.

A: Well, now what is it you want?

Q: What is the maximum capacity of the canal?

A: For continuous flow?

Q: For continuous flow.

1807 A: Oh, somewhere around 11,000 c.f.s.

Q: Well, then we will take the maximum flow in March, 1939, with a flow of 9311 cubic second feet, and will you give me the elapsed time of flow down the canal through Brandon Road Pool for the three distances from Damen Avenue to Summit, from Summit to Lockport, and from Lockport to the outlet of Brandon Road Pool?

1808 The P.W.A. Review Board first notified the Sanitary District of its approval of the Sanitary District report of April 1940, regarding the additional treatment facilities for West Side sewage by the activated sludge method on or about May 3, 1940. The amount of money which will be spent for this future construction work, including present contract obligations is about $12,000,000.

As to the progress on construction of this work, we have let a contract for blower equipment, have advertised one construction contract, are working on plans for the substructure of the blower house and incineration plant, are working on specifications for the drying equipment, that is, the boilers and other mechanical equipment which have to do with the drying of sludge. We have considered it wise to place the mechanical equipment under contract as quickly as possible because it takes the longest time to fabricate and deliver such machinery. We have not yet completed the final detail plans for all of the concrete work. It will require up until the end of next summer (1941) for such plans. We draw up construction plans in sufficient detail for taking bids, then after the work has been placed under contract and as the contract is being carried out, we furnish more detail construction plans. Such plans are required all during the construction period. We hope to get the substructure of the pump and blower house and of the incineration building under contract by next spring (1941) so that actual construction on the concrete and masonry work can start as soon as the construction season opens. We are taking bids within the next two or three weeks on one construction job for a tunnel which will pass from the present sludge drying building, southerly under the site of the future incineration building to the track south of the future building, so that we can get sludge out of the present building without interference with the construction of the new building so that the new construc-

tion will not cause any interruption with the operation of the present plant.

1811 We began preparation of the actual contract plans and specifications within three or four days after notice of approval by the P.W.A. Review Board. We had previously done a considerable amount of preliminary work and of course much of the work was in such shape that we could proceed at once on contract plans. I doubt if much of the new work at the Southwest Side Plant will be ready to place in service by the end of 1941, so that by the end of 1941 we will not be in a much better position with reference to the treatment of the West Side sewage than we are today.

1812 It was in 1934 that the P.W.A. Review Board suggested that experiments be made to determine the best method of supplementing the treatment of the West Side sewage. These experiments were made under the direction of Dr. Mohlman and men from the Division of Operation.

1813 The contract price for electricity sold by the Sanitary District to the City of Chicago is 8-1/2 mills per KW Hour, or 0.85 of a cent per KW Hour. The average price paid by the Sanitary District to the Public Service Company of Northern Illinois for electricity during the year 1939 was slightly less than 8 mills per KW Hour. In 1939 the Sanitary District of Chicago generated about 70,000,000 KW Hours of elec-
1814 tricity at Lockport; and about 7,000,000 KW Hours at the Southwest Treatment Plant as a by-product of the sludge drying process. The Sanitary District also purchased about 133,000,000 KW Hours from the

Public Service Company in 1939. In this year (1939) the Sanitary District used for its treatment plants, etc., about 82,000,000 KW Hours of electricity; sold the City of Chicago and the Park District about 123,-000,000 KW Hours; absorbed a loss in transmission and also current used by the Electrical Division in distribution of 5,500,000 KW Hours. The three figures of use of the energy and the three figures of the source of this electricity will balance at about 211,-000,000 KW Hours. The figures for the year 1940 are not yet completed but apparently they will be about the same as for 1939, except that the current generated at the Southwest Sewage Treatment Plant will be about twice what it was in 1939 because there was only six months operation in that year.

1815 Regarding the request for elapsed time for flow from Damen Avenue to the Brandon Road dam, I will assume that average flow past any given point is desired and will neglect the fact that the current is faster in one part of the stream and slower in others. We have made many flow tests in the Canal and most of this data was used in the original hearings in
1816 this case. We have made no flow tests recently to determine the elapsed time of flow through the channel. We made flow tests throughout the years from 1912 to 1926 but haven't conducted any experiments of that nature since. The elapsed time will be com-
1817 puted from data we have on hand. In such computations the fact that sludge may have been deposited in the channels in some places will be ignored.

HORACE P. RAMEY—Cross Examination.

2217 I was asked to compute the time of flow in the Chicago River and Main Channel from Damen Avenue to Brandon Road under certain conditions. The results can best be shown as an exhibit.

2218 Ramey Exhibits No. 1 and No. 2 were received in evidence.

2219 Ramey Exhibit No. 1 shows:

Date	Quantity	Time of Flow Damen Ave. to Brandon Road Dam
January 1939	2910 c.f.s.	112 hrs. 31 min.
June 1939	4227 "	81 " 0 "
June 1939	7891 "	40 " 0 "
June 1939	8311 "	38.5 " 0 "

Lake Michigan Elevation—1.15

Ramey Exhibit No. 2 shows:

Quantity	Time of Flow Damen Ave. to Brandon Road Dam
2200 c.f.s.	166 hrs. 8 min.
2800 "	118 " 8 "
10000 "	31 " 35 "

Lake Michigan Elevation—0.60

2221 The population increments used in the report to the Supreme Court for the ten years, 1930 to 1940, were

Calumet Project	45.6 per cent
North Side Project	34.0 "
West Side Project	8.6 "
Southwest Side Project	21.4 "

The total discharge capacity of all the water wheel units in the Lockport Power House is 12,633 c.f.s. There are two new units, installed in 1935, in this power plant which have a discharge capacity of 2,150 c.f.s. each, or a total of 4,300 c.f.s. There are five old units in this power plant (three installed in 1908; one in 1911; and one about 1914) with a discharge capacity of 1,667 c.f.s. each, or a total of 8,333 c.f.s.

2222- We do not have the 1940 population figures by 2223 districts on the various sewage treatment areas. All that is now available is the newspaper statement showing that the population of Illinois, as a whole, increased 3.2 per cent from 1930 to 1940. Figures for the City of Chicago show an increase of 8,118, or .2 of one per cent, in 10 years. The 1940 census figures show that the following municipalities in Cook County either gained or lost the following amounts from 1930 to 1940:

Municipality	Lost	Gained	Per Cent (Lost or Gained)
Blue Island	115		.7 of one per cent
Calumet City		437	3.6 per cent
Cicero	2164		3.2 "
Elmwood Park		2409	21.4 "
Evanston		1781	2.8 "
Forest Park		248	1.7 "
Harvey		1489	9.1 "
La Grange		313	3.1 "
Maywood		754	2.9 "
Melrose Park		173	1.6 "
Oak Park		1614	2.5 "
Park Ridge		1606	15.4 "
Wilmette		1739	11.4 "
Winnetka		206	1.7 "

The 1940 census figure for Cook County shows an increase of 67,208, or 1.7 per cent, from 1930 to 1940. The Sanitary District is all within Cook County and
2224 is almost as large as Cook County. The population of the Sanitary District for 1930 was 3,880,000. The population for Cook County in 1930 was 3,982,123, and for 1940, 4,049,331.

HORACE P. RAMEY—Cross Examination

3825 The electricity developed during the 10-day period of the flow test in the Main Channel from Noon, December 2, to Noon, December 12, 1940, by reason of the additional diversion of water, amounted to 2,516,-570 kilowatt hours.

3826 This is the excess amount over what would have been developed under ordinary conditions and if a value of .5 of one cent per kilowatt hour is used this additional power would be worth $12,500.

The sludge lagoon constructed within the past three months at the West Side Sewage Treatment Works is approximately 2800 feet long and 450 feet wide. The levies around the lagoon are about 8 feet high and there are several cross levies in the lagoon dividing it into different pools so that one pool can be filled
3827 with sludge at a time. This lagoon will handle the excess sludge from the West Side Imhoff tanks for about one year, that is, the sludge produced by that plant in addition to the amount of sludge which can be handled on the present sand drying beds. No definite plans have been made for additional lagoons for

handling sludge during 1942 but we have a tentative project for additional sludge lagoons west of the Lyons-Summit Road Bridge. Such lagoons would involve the construction of a pipe line from the West Side Plant to the site of the lagoon and the installation of a pump. This project will not be needed in any case for a year. Its construction depends on developments as to the absolute need for it.

In connection with the power developed at Lockport during the 10-day test, the average head on the water wheels during this test was approximately 30.4 feet compared to an average head of 39.0 feet prior to that date. The water used by the two new units
3828 in the Lockport Power House during the 10-day test was about 4500 c.f.s. for both units and the overall efficiency of these units is approximately 86 per cent. The remainder of the flow was used through the older units at the Lockport Power House, all of which have been in service for about 30 years. These old units have an overall efficiency of from 68 to 70 per cent. The use of these heads and these efficiencies will show why the increase in power does not vary directly with the increase in the flow. The Sanitary District purchases power at the point of use in Chicago for slightly less than .8 of one cent per kilowatt hour. Since power from Lockport must be transmitted to Chicago and is subject to line loss and other losses before it gets to the point of use is one reason why I have assigned a value of .5 of one cent per kilowatt hour for the value of power at Lockport. The two figures (.5 of one cent at Lockport and .8 of one cent at Chicago, are really consistent.

3829 The excess power developed during this 10-day flow test probably save the Sanitary District from buying a certain amount of power. The purchase price of electricity to the Sanitary District has been slightly less than eight mills per kilowatt hour but the District absorbs the losses in transmission and distribution so that I believe the power which is passed on to the City of Chicago at a price of 8-1/2 mills per kilowatt hour costs just about as much as is received from the City for it. The delivery point of power is at various points in Chicago and not at Lockport.

3830 I will furnish for the record the figure of approximate cost of the sludge lagoon recently constructed. We do not use any chlorine in such lagoons. Only well digested sludge is placed in sludge lagoons and there is not much if any odor to this sludge.

Mr. Pearse: The Sanitary District owns approximately 500 acres of land at the West-Southwest Side Sewage Treatment Works but west of Harlem Avenue along the Main Channel between this Channel and the Des Plaines River the District owns 1500 to 2000 acres.

3831 A: That is the site of these future sludge lagoons if we build them. This site of the future lagoons, if built, is 3 to 4 miles southwest of the Southwest Treatment Plant. This land is in a remote area between the Des Plaines River and the Main Channel and no people live within at least a quarter of a mile of any of this land. The West Side and the Southwest Side Plants are built in a neighborhood which

is sparsely settled at present but which will probably
3832 build up. This site for the future sludge lagoons, if built, is in a neighborhood which will never build up. The sludge lagoon recently built is immediately west of Battery B of the West Side Imhoff tanks and north of Battery B of the southwest area tanks.

When a lagoon is filled with sludge it is put out of further use for a long period of time, maybe 4 or 5 years. The sludge is pumped into a lagoon to a depth
3833 of about 6 feet and left to gradually decompose and dry out. The sludge which is to be put into lagoons is the same material which is placed on the sludge drying beds. Lagoons are cheaper than sludge drying beds and are just a makeshift. The sludge drying beds can be used over and over. They have sand underneath and a system of drains so that water can drain out of the sludge and there is a certain amount of evaporation from the sludge. The sludge is moist, perhaps 98 per cent moisture when it is placed on the drying beds and in the course of a week or 10 days under favorable conditions it dries out to a moisture content of about 80 per cent and then can be scraped off.

3834 In a lagoon there is no way for the water to drain from the bottom but there is evaporation and a certain amount of settling of solids to the bottom but there is also rainfall which probably offsets most of the evaporation.

The capacity of the West Side Plant is about 470 million gallons per day but I made no computations as to the acres of lagoons which would be needed if it was proposed to lagoon all the sludge from this

plant. Mr. Pearse will furnish figures as to the amount of sludge which will be produced from 100 million gallons per day of sewage.

3835 The present lagoon occupies about 30 acres. This lagoon was constructed by scraping dirt out of the body of the lagoon to build up a levy around it and cross levies across the lagoon.

Cross Examination

3836 I do not know exactly how much the City of Chicago still owes the Sanitary District for power furnished. I think it is somewhere in the neighborhood of $4,000,000. The Sanitary District has judgments for practically all of this. The Sanitary District furnishes about $700,000 worth of power per year and at the present time is receiving from the City a little more than the value of power being furnished. The judgments are collectable when and as the City can pay them and a good part of the money currently received is on the payment of judgments. It will take a number of years before these judgments are all paid.

Examination by the Master.

3837 The accumulation of these judgments, approximately $4,000,000, started back about 1925. I think the amount decreased slightly in 1940. Since 1933 I know that the amount due the Sanitary District from the City of Chicago for power has decreased materially and in recent years the general tendency has been to decrease the amount slightly.

Cross Examination.

The amount of judgments was greater in 1933 but I cannot state how much.

3838 I think that the Sanitary District is breaking even or practically even in purchasing power at .8 of one cent per kilowatt hour and selling it to the City of Chicago at 0.85 cent per kilowatt hour.

Examination by the Master.

The difference between .5 of a cent per kilowatt hour at Lockport and .8 of a cent in Chicago is what

3839 I allowed for costs of transmission and other losses. These figures are consistent.

3840 In connection with the 10-day flow test, I know what Mr. Andrew has testified to and my data checks or practically checks what Andrew has furnished.

Redirect Examination.

The sludge lagoon built at the West Side Works is for use next summer (1941). In this climate we do not dispose of sludge from Imhoff tanks in the winter time.

Examination by the Master.

The digestion of sludge either slows up or stops during cold weather so that Imhoff tanks are designed

3841 with sufficient capacity to retain all the sludge that

is settled out of the sewage over approximately a 4-month winter period and then with the return of warmer weather in the spring that sludge will digest and it is not placed on sludge drying beds or in a lagoon until it has digested so this lagoon will not be used until May, or perhaps June, 1941. At any rate, about May 1941 this lagoon will afford a method of disposal of sludge which has not previously been
3842 available. Mr. Pearse will furnish information as to the quantity. Also as to the cost of these lagoons.

Redirect Examination.

This lagoon is only for the sludge from the West Side Imhoff tanks. We do not propose to lagoon any activated sludge.

In connection with the 10-day flow test, there was considerable additional cost to the Sanitary District for a large force of men, for work 24 hours per day, under Dr. Mohlman, for an engineer and photographer, checking over conditions in the Illinois Valley because of possible damages, and because of other regular employees taken from their regular work.

Examination by the Master.

3843 Ramey Exhibit No. 3 and Ramey Exhibit No. 4 were received in evidence.

3844 Is Ramey Exhibit No. 3.

3845 Is Ramey Exhibit No. 4.

3846 Ramey Exhibit No. 3 is a map of Brandon Road Pool between McDonough Street, Joliet, and Brandon

Road Dam; showing at Station 38+91 a cross section of the Brandon Road Pool, at which section current meter measurements were made December 9, 1940. This map is traced from Andrew Exhibit No. 6 and another similar map. The distance from McDonough Street to Brandon Road Dam is about 6200 feet, or about a mile and a quarter. On this Exhibit is an arrow indicating the direction of the wind which was
3847 a moderate wind of about 14 miles per hour on December 9, 1940, slightly southwest, that is, this was the velocity of the wind at Chicago on that day. This Exhibit shows in a dotted line, beginning at McDonough Street and extending south, the path of a rod float, 15 feet long, placed vertically in the Channel at McDonough Street. This float drifted to the westerly bank of the pool at station 52+69. Another dotted line, beginning at the center of the stream at station 52+69 indicates the path of another float tube, 10 feet long, placed vertically in the water about the center of the stream at station 52+69. This tube drifted to the west bank of the pool at station 38+91. Obviously the wind blowing against the top 10 to 15 inches of these tubes immersed in the water 10 to 15 feet deep offset the downstream effect of the current and caused them to drift to the shore. The broken line on the Exhibit, extending from McDonough Street to Brandon Road lock, is the approximate center line of the stream or the sailing line. It is the line of the current.

3848 The 15 foot float tube referred to is 15 feet long below the water surface and an additional 15 inches long above the water surface; the 10 foot float tube is 10

feet submerged with an additional 10 inches above the water.

Ramey Exhibit No. 4 is a cross section of Brandon Road Pool at Station 38+91. This Exhibit shows in a full line the soundings of the Brandon Road Pool at this cross section, as determined by the United
3849 States Engineers in 1939, that is, soundings made with a 10-pound weight. This Exhibit shows in a dotted line the soundings made December 9, 1940 with a 30-pound weight on a current meter. The note on the Exhibit says, "30-pound weight on current meter stopped but would settle gradually into the sludge". The difference between the solid line and the broken line indicates fill in the pool between 1939 and December 9, 1940. At other points on the cross section are dots indicated by "X", being points at which current meter observations are made. These measurements were in every case made at .4 of the depth of the water measured down from the water surface,
3850 that is, .4 of the depth of the water at that point. The total depth was measured from the water surface down to the point where the current meter weight stopped. It should be approximately the same result as that obtained by the U. S. Engineers using a 10-inch disc, with a 10-pound weight, which was allowed to settle. In this case, the current meter had a 30-pound weight and the point indicated on the Exhibit is where the weight would stop but before it was allowed to settle into the sludge. So the figures should be about the same. These current meter measurements were made at .4 of the depth below the surface at various points across the stream. At two places

near the middle of the stream, measurements were made at .6 of the depth below the surface, as well as at the .4 point. Averaging all these velocities and applying the proper percentage of correction gives an average velocity over this entire cross section of
3851 approximately .53 of a foot per second, which compares with Mr. Andrew's average of .55 of a foot per second. The minimum velocity, as shown on Ramey Exhibit No. 4, was .27 per second near the east bank. The maximum velocity was 1.33 feet per second at the .4 depth point near the center of the stream. Station 450 on Ramey Exhibit No. 4 is near the sailing line shown on Ramey Exhibit No. 3. This is at a point at which the nearest indicated velocity on Ramey Exhibit No. 4 on the right hand side is 0.74 and on the left hand side is an average of 1.01. We have no velocity figures at the outlet of the gates from Brandon Road Pool but I know that the velocity over
3852 the dam must have been very high. The velocities of water in the Brandon Road Pool are probably a third or a fourth of the velocities in the Main Channel above Lockport under normal conditions.

I believe that this 10-day experimental flow did not result in scouring out the Brandon Road Pool because of the tremendous quantity of material scoured out of the Main Channel above the Pool and not scoured out as quickly as had been hoped. If all the material above Lockport had been scoured out within the first five or six days of the test, leaving the water going into the Pool during the last four days of the test relatively clear, such water might have taken more material out of Brandon Road Pool. The ten-

dency towards the clearing up of the water at Lockport is shown in Mohlman's report. Suspended solids in the water during the latter days of the test were diminishing at Lockport, whereas in the water com-
3853 ing out of Brandon Road Pool such solids were not diminishing greatly. I think that this is one element that was over estimated. I do not think that the sludge that went into the upper end of the Pool carried through the Pool as well, perhaps, as we had hoped. However, when 21,000 tons of sludge were carried from the Pool there was some beneficial effect on the system (from Chicago to Brandon Road Dam) as a whole. This experiment has removed 21,000 tons of material that was previously between these points and the situation between Chicago and Brandon Road has been improved to that extent although the situation in Brandon Road Pool is worse than it was.

Cross Examination.

3854 I would say that as a result of this 10-day test, the Chicago River and the Main Channel of the Sanitary District to McDonough Street Bridge should be relatively clean and that lake water entering the Main Channel will not have as much dissolved oxygen absorbed from it by sludge deposits in the Main Channel in 1941, as well as the case in 1940, and assuming that there is enough water to supply the oxygen demand of the treatment plant effluent the lake water would reach Brandon Road Pool in relatively better condition in the summer of 1941 than in previous

summers. I would say that the worst sludge deposits are now concentrated in an area about 5000 feet long by 1400 feet wide, as compared to being spread over a distance of 30 miles previously. I would hate to say that there is no sludge in any part of the system even now, although I think that the rest of the system is relatively clean.

3855 As a result of this 10-day test, a considerable amount of B.O.D. has been removed from the Canal system from Chicago to Brandon Road and in my opinion that is helpful.

Redirect Examination.

This statement is based, more or less, on the report
3856 of Dr. Mohlman, and when I say "relatively clean", I mean that some sludge has been removed from the Main Channel but whether or not there is any more and to what extent there is sludge in the Main Channel, I don't presume to testify as to any exact figures but I think what I have said is consistent with what Mohlman's report shows.

Recross Examination.

Illinois Exhibits Nos. 10-D, 10-E, and 10-F were received in evidence. These exhibts bring down to date the data shown on Illinois Exhibits Nos. 10-A, 10-B and 10-C. Said exhibits are shown, pages 3857 to 3860.

Examination by the Master.

3861 The normal level of Brandon Road Pool is elevation 539 feet above sea level. In order to induce the flow of 10,000 c.f.s. the pool had to be lowered about one-half foot, or to an elevation of 538.5 feet at Brandon Road.

On Saturday, December 7, 1940, between 10:00 o'clock A. M. and Noon, the water level at Brandon Road Dam was lowered an additional one foot and that level was maintained until Midnight, December 8. Then, the level was brought up to 538.5, so that the lowering of the pool over that week-end amounted to one foot. The amount of this lowering was determined by the United States Engineers. I called Mr.
3862 Andrew, of the U. S. Engineering Department, on Thursday, December 5, 1940, and asked him to lower the pool at least four feet for 24 hours over the week-end, Saturday and Sunday, December 7 and 8. I asked Mr. Andrew to consider this a formal request for lowering of the pool and on Friday, December 6, I again called Mr. Andrew and he informed me that he had instructed his men at Brandon Road to lower the pool a foot and a half below normal, beginning Saturday noon. He did not think it proper to order a further lowering; that Government employees would do the lowering, and this was as far as he had any authority to go under the circumstances. He indicated that there were objections from the Government standpoint to further lowering but did not tell me what they were. I transmitted this information to Mr. Clausen and I think he embodied it in a letter to the Spe-

3863 cial Master. I talked to Mr. Andrew about operating the levels of this Pool on December 2 and 3, but my first definited and specific request for a lowering was made on December 5. If the level of the pool had been lowered about 4 or 5 feet, I do not believe the results would have differed greatly from those actually obtained. I think that the velocities in the Pool would have been decreased in direct proportion to the diminishing of the cross section by such lowering but when a velocity of approximately .5 feet per second is increased about 25 or 30 per cent, there is still not sufficient velocity to do much good. There is certainly not a scouring velocity and while there might have been comparatively small amount more of sludge carried out of the pool, I don't think the difference would have been great.

Recross Examination.

3864 Such a difference could be checked by taking the number of tons moved on any one day and if that amount were increased it might go up to a thousand tons more than was moved but I doubt it.

In order to create velocities sufficient to scour that pool, I think the velocities would have had to be treb-
3865 led of quadrupled. The pool would have had to be lowered to a point where it would have been possible
3866 to get an average velocity of about 1-1/2 feet per second. The increased velocity due to lowering of the pool level of 5 feet would have transported some more material but I don't know how much and I don't

think anyone does but it would have increased the
3867 transport of material slightly. In order to have effected a substantially different result, it would have been necessary to lower the pool to an amount sufficient to obtain a velocity well over one foot per second and that means lowering the pool something like 10 or 12 feet. I don't think that the lowering of this pool a foot made much difference and I don't think that if it had been lowered 5 feet it would have made any substantial difference. I am not sure that the extra or additional material moved during the 36 hours of lowering was caused directly by that lowering.

Master's Examination.

3868 To have lowered the pool 10 feet would have absolutely blocked navigation in the upper end of the Brandon Road Pool, in fact, a lowering of 5 feet would stop 9-foot navigation.

Recross Examination.

With a flow of 10,000 c.f.s. going through Brandon Road Pool, the more that the pool level was lowered the less would be the material which would settle in the pool. When there is a velocity of one-half foot per second certain solids in the water will settle and that was the average velocity in the pool at elevation 538.5, which elevation is half a foot below the normal level.

Examination by the Master.

3869 A velocity of 1 3 feet per second was observed at .4 of the distance down from the surface of the water to the center of the stream. At other places in the stream at the .4 depth point, different velocities were observed but the average velocity over the whole cross section was about .5 foot per second, in my computations and also in those of Mr. Andrew.

387(Recross Examination.

If the depth of water was 20 feet and the current meter observations were made at .4 depth point, the current meter was 8 feet down below the surface. I don't think any material was transported by the water over near the bank where there was a velocity of .2 or .3 or .4 ft. per second. I think that all the material which was transported was transported by the water out in the center of the stream moving at a higher velocity. Nobody is sure of this. It is all a matter of conjecture.

3871 The velocity of water through this pool varies in direct proportion to the decrease in the cross section. Mr. Clausen is going to introduce data regarding the water intakes in the Brandon Road Pool.

July, 1940, at Chicago.

LANGDON PEARSE, on behalf of Petitioner.

Direct Examination by Mr. Clausen.

131 I am the Sanitary Engineer of the Sanitary District. I was graduated from Harvard College with degree of A.B. in 1899, and from the Massachusetts Institute of Technology in 1901, B.S. in Civil Engineering, and in 1902 received M.S. degree in Sanitary Science. My

experience has covered as Assistant Engineer: On the Charles River Dam Commission in 1902; On the Com-
132 mission on Additional Water Supply, New York City, in 1903; Augusta (Maine) Water District in 1904; Water supply investigation for Jersey City and Cleveland in 1904. In 1904-1907, was Assistant Engineer on the Improved Water and Sewage Work at Columbus, Ohio. In 1907 and 1908 was Assistant Engineer on Filtration with the Peoples Water Company in Oakland, California.

From February, 1909 to date have been with the Sanitary District, and since 1919 have been the Sanitary Engineer in charge of sanitary investigations and sanitary engineering work. I have also been employed from time to time as a consultant by various cities in Illinois on sewage treatment.

133 I have appeared as a witness in this case in 1927, 1929, and 1933. I was employed by the State of New Jersey in connection with the litigation over the taking of Delaware River water by the State of New York, and by the State of Connecticut in connection with the taking of the Ware River water by the State of Massachusetts.

At present am Sanitary Engineer for the Sanitary District, without any other engineering connections.

I understand the Illinois Waterway to comprehend the waterway from Lake Michigan to the Mississippi River.

134 I am informed on the sanitary condition of the Illinois Waterway, through a special division with chemical laboratories along the Waterway, and confer daily with Dr. Mohlman, our Director of Laboratories.

135 I directed the design of the North Side Works, the Des Plaines, and the old Calumet Works, and have served as a consultant on the design of the West Side, Southwest, and Calumet Works.

I have prepared data from the daily operating record of the sewage treatment works of the Sanitary District to show monthly averages of the 5-day B.O.D. and the suspended matter, as well as the removal thereof. The term B.O.D. comprehends the 5-day bio-
136 chemical oxygen demand, which indicates the extent of organic pollution, as measured by the oxygen required in parts per million to satisfy the 5-day demand.

137- The tabulation is offered for the North Side Works
148 from 1929 to May, 1940, inclusive (Illinois Exh. 20).
149 These tables show monthly averages, enumerating the flow in million gallons daily, the 5-day B.O.D. of the raw sewage entering the plant; the 5-day B.O.D. of the effluent as discharged to the North Shore Channel; the percentage reduction in the operation of the plant; the dissolved oxygen in the final tanks and in the effluent or the outfall since 1934, in parts per million. The suspended solids are shown in the raw sewage entering the plant and in the effluent, with the percentage reduction.

The North Side Works went into operation on October 3, 1928; the records in 1928 are inconsequential
150 as the plant was tuning up.

The North Branch Pumping Station was placed in operation on June 28, 1930. At that time the North Side Works received practically its entire load.

151 The new Calumet Sewage Treatment Works was

actually put in operation on December 3, 1935, pumping sewage through the preliminary tanks. The aeratanks went into service on December 16, 1935.

152-156 The monthly operating averages are shown from January, 1936 through May, 1940, in Illinois Exh. 21.

157 The West Side Treatment Works went into service with Battery A on June 2, 1930. The second Battery B was put in on June 14, 1930. Battery C went into service on April 29, 1935.

158-168 The monthly operating averages are shown in Illinois Exh. 22.

169 Pumping began at the Southwest Works on May 23, 1939, with the preliminary tanks in use. On June 9, the activated sludge plant started with the first battery and was gradually put into complete service on June 27, 1939. The second battery was put into half service on September 6, 1939, and in full service Oc-

170-171 tober 26, 1939. The monthly operating averages are shown from May 1, 1939 through May, 1940 in Illinois Exh. 23.

172 At the North Side Works, the efficiency is high, as shown by the monthly averages in 1938, 1939, and 1940.

172 The B.O.D. removal during the summer months has averaged 93 to 95 per cent. The excess sludge is piped to the Southwest Works. Through 1939, practically all North Side sludge was discharged into the Main Channel at Stickney because of lack of capacity for sludge handling in the Southwest Works. The operation of the Calumet Works is handicapped by certain industrial wastes, chefly acid pickling liquor and paint waste. Continuous attention has been given to in-

creasing its efficiency. The efficiency of B.O.D. removal has increased from 83.5 per cent in 1936 to 87
173 per cent in 1939. The efficiency at the West Side Works in removing the 5-day B.O.D. and the suspended matter has been high for a sedimentation plant, ranging from 40.2 to 63 per cent on yearly averages from 1936 to 1939 inclusive. Higher removals have been attained during the summer months, with monthly averages up to 56 to 58 per cent on the 5-day B.O.D. and 61 to 70 per cent on the suspended matter. Ample digestion space for the West Side solids has been available since 1935. The sludge drying beds are adequate for digested sludge from the West Side area.

At the Southwest Works, the tuning-up period was still in force on July 12, 1940. A tuning-up period is necessary to iron out operating and structural difficulties and to train some 370 men. More blowing capacity is required, as was anticipated at the begin-
174 ning of construction, but could not be done because of lack of funds.

174 The Calumet Works has consistently been unable to produce results as good as the North Side because of industrial wastes which interfer with the bacterial processes. Such wastes are being eliminated at the factory by removal from the sewers, as in the case of iron wastes, or through change of factory procedure.

At the West Side Works from year to year since 1931, the results have varied. Monthly averages of B.O.D. removal have ranged from 28.8 to 63.5 per cent from June to September inclusive, from 1931 to 1940. The removal of B.O.D. has ranged from 40.7 to 53.7

per cent on yearly averages. In the last five years the lowest monthly removal during June to September inclusive was 44.4 per cent.

175 Since 1931, the yearly average removal of suspended solids has ranged from 40.2 to 63 per cent. On monthly averages, the removal of suspended matter has ranged from 45.7 to 77.1 per cent during June to September inclusive, from 1931 to 1939. During the last five years, the lowest monthly average removal during June to September inclusive was 46.7 per cent.

Chemical treatment comprehends the addition of chemicals, such as ferric chloride, ferric sulphate, lime or variations or combinations of various chemicals to sewage with suitable mixing, followed by a period for coagulation and settling. The procedure is used frequently to increase the removal of suspended matter
176 and B.O.D. Chemical treatment is not new but has been practiced for over 70 years. The application of chemical treatment to the West Side Works would not double the removal of B.O.D. and suspended solids. In many months the removal actually obtained by plain sedimentation was over 50 per cent. During the period from June to September, 1931 to 1939 inclusive, a total of 36 months, in only 9 months was the removal of B.O.D. below 50 per cent, and in only 5 months of the suspended matter. In the same four-months period in 1939, the removal of B.O.D. ranged from 56.2 to 58.8 per cent, and of suspended matter, 61.8 to 70.2 per cent. Tests run by the Sanitary District on chemical treatment show only a very slight betterment over plain sedimentation.

At the Southwest Works pumping sewage began from the West Side intercepting sewer on May 23, 1939,
177 through the preliminary tanks. Activated sludge treatment began on June 9, 1939. The first battery of activated sludge went into service on June 27, 1939. The dewatering and incineration of solids began on August 7, 1939, and has been in continuous operation ever since, except for certain units taken out for alterations or repairs. Two units are in service (July 12, 1940) and two are under repair and should be in service within 30 days. Changes have been necessitated in the steaming capacity of the boilers because the drying system is combined with the generation of steam for running the turbines on the pumps and blowers.

In starting a large sewage works like the Southwest
178 Works, a tuning-up period is necessary, to adjust and correct apparatus and train the operating crew. The apparatus must be tested completely, and its efficiency determined. The Southwest Works is a very unusual and novel plant, because of the method of heat-drying and incineration of solids. This was originated and developed by the mechanical engineering forces of the Sanitary District.

179 The Calumet plant went into operation first, handling 30 tons of dry solids per day, but it only incinerated sludge and had no boilers. In the Southwest Works, the steam generating capacity has to be balanced with the drying capacity, as well as with the feed of ferric chloride, feed of cake, and other details. The Southwest Works is the largest sewage works of its kind in the world. Intensive training of the operat-

ing personnel and drafting of instructions for operating to meet contingencies and emergencies are necessary. A tuning-up period of at least a year is necessary and under our conditions somewhat longer at such a development period.

180 The million gallons of sewage given complete treatment and that given preliminary settling is shown on the Illinois Exh. 22. At present (July 12, 1940) all the flow is going through the aeration tanks. The preliminary sludge is pumped over to the West Side Imhoff tanks for digestion. The North Side sludge is mixed with the excess activated sludge from the Southwest Works. Most of this is dewatered, heat-dried, and sold as raw material for fertilizer. The balance is discharged into the Main Channel (as of July, 1940). In May, 1940, 2,000 tons of dry solids were discharged to the Main Channel from the Southwest Works, or approximately 17 per cent of the suspended solids in the sewage of the Sanitary District.

181 No sludge has ever been discharged from the West Side Works to the Main Channel. The Sanitary District has steadily increased the removal of solids from the sewage. The Des Plaines River and the old Calumet plants are not in the present picture, as the Des Plaines River plant was shut down in October 13, 1931, and the Calumet Imhoff plant was shut down
182- on September 15, 1935. The record from 1929 to
183 1940 (first 5 months) shows an increase from 54.1 to 393.5 tons per day (Illinois Exh. 24, 26).

Upon the completion of the Sanitary District program, between 475 and 500 tons will be removed daily,

depending upon the state of the population and industry and the efficiency of the plants.

184 The Sanitary District has increased the amount of
186 sewage treated from 67.9 million gallons per day in 1928 to an average of 826 million gallons per day during the first five months of 1940 (Illinois Exh. 25).
188 This is shown graphically in Illinois Exh. 26. The
189 sharp increases in gallonage treated are due to the starting of new plants, such as the North Side on October 3, 1928; the West Side in 1930; and the Southwest in 1939. From 1928 to 1940, there is an increase of nearly 40 per cent.

190 For the past five years, the plan has been shaped to run the Southwest Works to capacity, diverting West Side sewage to it during dry weather, and putting excess storm flow into the West Side Imhoff tanks from the Southwest sewage system. The Sanitary District has recognized the need for additional treatment to supplement the West Side Imhoff tanks for many years. Consideration was given at the time of the tank design. A plan was submitted to the P.W.A. in 1933 for handling the Southwest sewage and the West Side effluent in a combined plant of 1,000 mil-
191 lion gallon per day capacity. The P.W.A. Board indicated it was better to build the activated sludge plant for the Southwest and thereby get the largest amount of gallonage under treatment in the shortest time. The determination of how best to supplement the West Side Works was delayed by the P.W.A. Review Board until the Southwest Works were under contract. The Board also recommended large scale tests to determine whether any combination of Imhoff tank treat-

ment and chemical treatment, with or without filtration, would be sufficient, and also the preparation of estimates of cost. The advisability of chemical treatment to supplement the West Side Works was before the Sanitary District prior to 1934. The decision was to concentrate on the Southwest Works and then take
192 up the experimental procedures. In this the P.W.A. Board and the Sanitary District agreed. Procedures were studied from 1936 to 1939 for supplementing the West Side Works, including the activated sludge process with short period aeration, chemical precipitation, filtration on fine grained filters (Laughlin or magnetite), aeration with iron salts (Guggenheim), and high-rate trickling filters, both single stage (Halvorson type) and two stage (Jenks type).

193 Plans were drawn in 1936 for the chemical treatment tests, to include mixing and coagulation tanks, and chemical dosing apparatus; the arrangement of an Imhoff tank unit for parallel tests on the chemically treated sewage and the settled sewage; the behavior of sludge digestion; and the effect of filtration (Laughlin) on settled and chemically treated sewage. This went into service in September, 1937, and operated for a year. The results of these tests indicated that chemical precipitation made a very slight improvement in the quality of the West Side effluent.

The field tests were supplemented by estimates because there was no question but what the activated sludge process produced a higher grade effluent than the chemical treatment would. Detailed estimates were made on two schemes for activated sludge, on chemical precipitation, and on the filtration with fine

grained filters of the plain settled effluent and chemi-
194 cal precipitation effluent. Aeration with iron salts and high rate trickling filters were too expensive for the results obtained. Filtration on fine grained filters was also too costly for the relatively small benefit. This comparison of the various alternatives narrowed the field to activated sludge and chemical treatment. But these two procedures were not equivalent in the work performed. The choice was determined by the degree of effluent required to preserve at least three parts per million of dissolved oxygen in the Des Plaines and Illinois Rivers. The maintenance of freedom from odor in the absence of sludge banks requires the pres-
195 ence of some dissolved oxygen. The margin of safety between complete de-oxygenation and the presence of appreciable dissolved oxygen cannot be estimated in the operation of treatment works so as to make it possible to adjust the dilution so that one or two parts per million of dissolved oxygen will always be present. To maintain a factor of safety in preventing nuisance, a minimum of three parts per million of dissolved oxygen is required. To protect fish life, three parts per million of dissolved oxygen is a minimum. Some authorities recommend five.

In maintaining the Illinois Waterway, a number of factors are beyond the control of the Sanitary District, such as the cessation of reaeration at dams by the development of water power. Such reaeration is of value
196 in the self-purification of the Waterway. The effect of an ice sheet on reaeration is not definitely known. Our early data, running back to 1919, indicates that in severe winters more flow may be required than in

normal summer conditions. Luckily, extreme winters occur but seldom. The diversion may be changed. The possibility of any further reduction appears remote. The growth of population and industry within the area of the Sanitary District are both a factor. The requirements laid down for stream conditions by authorities having jurisdiction thereover may change. At present the power of regulation rests in the State of Illinois. In the near future control may be given also to a Federal authority. The general trend of regulation points to more rigorous standards for the sanitary conditions of waterways than was the case ten to twenty years ago. The necessity for budgeting the diversion from Lake Michigan to offset the storm run-offs cuts down the effective allowed diversion. 197 Such budgeting means that for at least six months a diversion between 800 and 1000 c.f.s. may be in use. In general, this has reduced the flow from Lake Michigan during the warmer months of the years at a time when the dissolved oxygen content of the lake water is lowest. That is the time when the most dissolved oxygen is needed, aside from the occasional heavy ice sheet.

The oxygen balance in the Upper Illinois Waterway requires a high degree of treatment at the West Side Works. Based on a diversion of 800 c.f.s. with 500 m.g.d. passing through the Southwest Works and receiving activated sludge treatment, a treatment is required at the West Side Works greater than 82 per cent for the 400 m.g.d. passing through the works. Supplemental treatment for the West Side Works is required, making an overall purification of 90 per cent

or better to maintain three parts per million of dissolved oxygen at Lockport.

197 Seasonal effects are important, both as to the amount of dissolved oxygen which can be introduced into the canal system by the diversion and the temperature of the lake water and effluents and mixtures
198 thereof, in so far as temperature affects the rate of satisfaction of B.O.D. The temperature of Lake Michigan varies from 32 degrees Fahr. in winter to 72 degrees Fahr. in summer. The dissolved oxygen content varies from 14.6 parts per million in winter to 8.8 parts per million in summer. The temperature of the Lake water and effluents and mixtures thereof affects the rate of satisfaction of B.O.D., the rate being slower at lower temperatures. Aside from the effect of the ice sheet over the waterway, such seasonal occurrences point to the need of the greatest reduction in B.O.D. during the summer months. This corresponds in general with the periods of lower diversions.

199 The Activated Sludge plant was chosen for supplementing the West Side Works because a high-grade effluent was required, such as only an activated sludge plant can deliver, with an effluent containing only 10 parts per million of B.O.D. or less.

The treatment by the various procedures produce an effluent containing a residual B.O.D. as follows:

Procedure	Residual B.O.D. p.p.m.
Imhoff tank	57
Imhoff plus chemical precipitation	36
Activated sludge	10

The treatment by various procedures produces a removal of B.O.D. and suspended solids as follows:

West-Southwest plus West	Per Cent Removal	
	B.O.D.	Susp. Solids
Activated plus Imhoff	73.7	76.7
Activated plus Chemical Precipitation	81.7	81.9
Activated plus Activated	91.6	91.5

200 The activated sludge process offers a possibility of revenue from the sale of heat-dried activated sludge, perhaps $4.00 a ton after paying for fuel, or $78,000. Labor cost for chemical precipitation on 400 million gallons of West Side effluent per day is $39,000 greater than for activated sludge in a year. Both may fluctu-
201 ate. The cost of coal and chemicals is $205,000 higher for chemical precipitation than for activated sludge in a year. There is more risk of fluctuating costs in chemical precipitation than in activated sludge.

In making a comparison of construction cost estimates of activated sludge and chemical precipitation, the two schemes basically are of different accomplishment. The plans proposed at the time the estimates were made included the increase in the capacity of the Southwest Works to 500 million gallons per day on an activated sludge basis.

202 The first costs for a complete setup are as follows:

Procedure for Addition to West Side	Extension Southwest Works to 500 m.g.d.	Extension West Side to 400 m.g.d.	Total for 900 m.g.d.
Activated Sludge	$3,879,800	$5,869,000	$9,749,700
Chemical Precipitation	3,879,800	1,300,500	5,180,300

Comparison on the basis of adding sufficient activated sludge treatment to produce a 5-day B.O.D. discharge equal to that derived from treating 400 m.g.d. by chemical treatment, indicates a capacity of 180 m.g.d. is required for activated sludge. The first cost is changed for the activated sludge extension of the West Side as follows:

Extension of West Side	Capacity m.g.d.	Cost
Activated Sludge	180	$3,662,000
Chemical Precipitation	400	1,300,500

This would materially reduce the annual cost of activated sludge, were a lower degree of treatment satis-
203 factory for the extention of the West Side Works. The total annual costs of the complete setup are practically the same, as follows:

Procedure for Addition to West Side	Extension Southwest Works to 500 m.g.d.	Extension West Side to 400 m.g.d.	Total for 900 m.g.d.
Activated Sludge	$579,400	$569,200	$1,148,600
Chemical Precipitation	579,400	555,800	1,135,200

These figures show no credit for the sale of heat-dried sludge for fertilizer, which is estimated to exceed $78,000.

The cost of extension of the Southwest Works by activated sludge to 500 m.g.d. is the same for both alternatives.

204 If the total annual cost be corrected to a West Side activated sludge extension producing the same B.O.D.

as for chemical precipitation, the annual cost is as follows:

Procedure for Addition to West Side	Extension Southwest Works to 500 m.g.d.	Extension West Side	Total
Activated Sludge	$579,400	$320,600	$900,000*
Chemical Precipitation	579,400	555,800	1,135,200**

* For 680 m.g.d. ** For 900 m.g.d.

No credit is shown for the sale of heat-dried sludge as fertilizer.

The activated sludge altenative is advantageous in financing, as it keeps down the operating costs and thus reduces the corporate tax levy. The proposed works will
205 relieve the conditions in the Brandon Pool. The works can be built by the end of 1942. A site is available on the 501 acres now owned in Stickney, upon which the existing West Side and Southwest Works are located. Conditions in the Illinois Waterway were very unsatisfactory in 1939 and 1940. During July, August and September, 1939, the dissolved oxygen in the Main Channel at Damen Avenue was exhausted for the first time in 40 years. At Summit, the dissolved oxygen was absent for six months and practically exhausted for eight months. At
206 Lockport, the dissolved oxygen was exhausted for six months and was below two parts per million for four months beside. The Joliet Pool was in bad shape, with marked gasification and, at times, scum formation. Conditions in the Illinois Waterway from Lockport to Brandon Road were worse in 1939-1940 than in 1938,
207 after the cut in the diversion. No temporary measures

are available which can be quickly applied to obviate the conditions in the Brandon Road Pool other than an increased diversion.

Conditions improved somewhat in 1940 by reason of the additional treatment in the Southwest Works and the prevention of sludge from entering the Channel. These conditions will continue to improve as the Southwest Works are brought up to capacity and the West Side supplemental works are built.

208 The decrease in the B.O.D. reduction at the Southwest plant in April and May, 1940, as compared to January and February, 1940, was due to certain conditions in the plant which were being corrected. The operating efficiency got out of gear. In July, 1940, the pumping was about 350 m.g.d., of which 250 m.g.d. received complete treatment.

209 Conditions since 1939 have improved in the Waterway. Gasification from sludge deposits will decrease. There is a double demand from sludge deposits, partly from sludge coming contemporaneously and partly from past deposits, particularly during the winter.

210 The improvement in conditions should be reflected by the increase in gallonage treated in 1939 and 1940. We have insisted that the plants remove the solids and treat as much liquid as possible. The operating force is doing its best to perform under these orders. The diversion limitation became effective on December 31, 1938. The removal of solids is a table which indicates the effectiveness of treatment.

The repairs to the drying apparatus and the additional filters now under contract will also help keep sludge from being wasted to the Main Channel. There

has always been a heavy deposit of sludge above the Power House from the Power House to the old controlling works. In 1909, from 6 to 8 feet of deposits were measured on the racks of the Power House. The wide area and lowered velocities tends to deposit solids. There have always been some sludge deposits in Bran-
212 don Pool since the gates in the dam were closed in 1933. The dams at Brandon Road, and to some extent at Dresden Island, retain sludge in the upper part of the Illinois Waterway. The capacity of the Pool is approximately 150 million cubic feet. The Pool is about 4 miles long and from 600 to 1000 feet wide. The width
213 varies from around 200 to 400 feet to a maximum of about 1400 feet just above the dam. Brandon Road Dam is the first dam below Lockport Power House and Joliet. From the Power House to Brandon Dam is 5.1 miles.
214 Sundays, holidays, and industrial depressions affect the condition of the Waterway. The sewage is weaker over Saturday and Sunday and stronger during the middle of the week, where industrial wastes are a factor.

The time of flow between Chicago and Lockport and Brandon Road Dam is considerable. From Chicago to Lockport is now a flow time of about 2-½ days. Hence the effect of what happened in Chicago today is seen at Lockport two and one-half days later. At the time of the Master's visit on Monday, July 8, 1940, the con-
215 dition reflected a more or less general holiday from Thursday through Sunday. This year Lake Michigan warmed up more slowly. Conditions have been much worse at Joliet.

216 Sludge deposits persist for several years, and the effect of a sludge deposit in a stream may last more than two years, perhaps two and one-half to three years. As the plants are completed, with their sludge handling devices, there is less sludge going down the Channel.

217 I have urged for more than two years that the Southwest Works be completed and the West Side Works supplemented at the quickest possible opportunity, with appropriate treatment serviceable for permanent use. There is no value in seeking temporary alleviations of minor importance that cost a large sum of money. I know of nothing that would produce the same results that we ought to have to cure the conditions that existed, except to suggest that diversion would be the quickest way and probably the most satisfactory. The 5,000 second feet annual average diversion would be sufficient to make conditions in the Brandon Pool that would not cause difficulty. I have not examined the case sufficiently to determine whether or not a much lower flow would be satisfactory. I believe 5,000 second feet
218 would be highly desirable, particularly during the summer months, when the greatest gasification occurs. This would relatively improve the position over what it was when 5,000 second feet was allowed, but as a citizen I feel the citizens of Joliet are entitled to better conditions than existed since the pool was closed and the sludge has been accumulating. The treatment was not in service soon enough to prevent conditions which are not proper. Everybody has realized we were doing our utmost to build our plants within our resources and

also doing our best to operate the plants to the greatest advantage.

221-223 The summary of the yearly averages of the operating results at the North Side Works for 1929 to May, 1940 is shown in Illinois Exh. 27.

224-225 The summary of the yearly averages of the operating results at the Calumet Sewage Treatment Works is shown for 1936 to May, 1940 in Illinois Exh. 28.

226-227 The summary of the yearly average of the operating results at the West Side Sewage Treatment Works is shown for 1931 to May, 1940 in Illinois Exh. 29.

LANGDON PEARSE:

Direct examination by Mr. Clausen.

1433 The significance of the various headings on the tables in Illinois Exh. 20 (Rec. 137) is as follows: The tables for the North Side Works show for each month in the respective years the daily average data, for the years 1929 to 1940 inclusive—first, the flows in million gallons per day, abbreviated as m.g.d.; next, the 5-day B.O.D. for the raw sewage entering the works and the effluent discharged to the North Shore Channel, in parts per million and the per cent reduction caused by the treatment; next, the dissolved oxygen in parts per million in the effluent at the final settling tanks and also at the outfall where it enters the North Shore Channel; and, finally, the suspended solids in parts per million in the raw sewage and effluent and the reduction in per cent caused by the treatment. In each year, except 1940,

the average for each column of results is shown at
1434 the bottom of the table. This average is the daily average for each respective year.

Supplemental table for the year 1940, showing the data for June and July, was introduced for the North
1435 Side Works, Illinois Exh. 44. Illinois Exhibit 44 in-
1436 cludes the material shown in Illinois Exh. 20. The same general headings are used in Illinois Exh. 21 as in Exh. 20.

1437 A supplemental table for the Calumet Works, in-
1438 cluding June and July, 1940, was introduced as Illinois Exh. 45.

1439 The same general headings are used in Illinois Exh.
1440 22 as in Exh. 21, but no dissolved oxygen is given.

A supplemental table for the West Side Works, in-
1441 cluding June and July, 1940, was introduced as Illinois Exh. 46.

1442 Illinois Exh. 46 covers the year 1940 through July, for the Southwest Works, including Illinois Exh. 22. The general headings in Illinois Exh. 23 are similar to those in Illinois Exh. 20. The average of each column, however, as shown, is for only 6 months.

1443-1444 Illinois Exh. 47 covers all of Illinois Exh. 23
1445 and also through July and August, 1940.

In the transcript (Rec. 180) with reference to the proportion of the sewage solids of the Sanitary District, I meant 17 per cent of the suspended solids in the raw sewage.

1446 Supplementing Illinois Exh. 24, the daily average for the first seven months of 1940 of the tons of dry solids removed per day calculated from the removal of suspended soldis in the respective plants was:

Plant	Tons per Day
Calumet (new)	30.2
North Side	106.6
Southwest	187.5
West Side	73.1
Total West-Southwest	260.6
GRAND TOTAL	397.4

The saturation value of dissolved oxygen in water at 72 deg. Fahr. is 8.8 parts per million (Rec. 198).

Referring to Illinois Exh. 27, the daily average for the first seven months in 1940, as compared with the first five months, at the North Side Works were:

1447

Daily Averages		
Determination	Months	
	7	5
M.g.d.	191	190.5
Effluent: in p.p.m.		
B.O.D.	7.7	8.4
Suspended Solids	11.7	13.0
Per Cent Reduction:		
B.O.D.	94.04	94
Suspended Solids	91.9	91

At the Calumet Works, the daily averages were:

Determination	Months	
	7	5
M.g.d.	66.4	66.3
Effluent: in p.p.m.		
B.O.D.	8.86	9.0
Suspended Solids	11.9	12.0
1448 Per Cent Reduction		
B.O.D.	91.4	91.5
Suspended Solids	90.2	90.2

At the West Side Works, the daily averages were:

Determination	Months	
	7	5
M.g.d.	339	307.1
Effluent: in p.p.m.		
B.O.D.	66	67
Suspended Solids	75.6	76
Per Cent Reduction		
B.O.D.	48	46.4
Suspended Solids	54.7	52.7

1448-1449 The amount of air used in the various plants
1450 of the Sanitary District is shown in Illinois Exh. 48.
1451 I showed the results at the North Side from 1930 on, as the early record was not for complete operation. The results in 1929 were of no great significance for this picture. At Calumet, the few days of activated sludge in December, 1935, were omitted. The figures given in Illinois Exh. 48 are for air in decimals of a cubic foot per gallon of sewage. The average for the year is shown, except that in 1940 at the North Side and Calumet the average of seven months is given, whereas at the Southwest it is for six months in 1939 and in 1940.
1452 The estimated flow of sewage, with the amount
1453 treated and untreated is shown in Illinois Exh. 49 for
1454 the years 1930 to 1940 inclusive. The total pumpage is built up as the sum of the pumpage of the Des Plaines River watershed, the municipalities within the District not served by Chicago and the City of Chicago. The
1455 first figure in the third column should be "1097," not "1099." The sewage flow is assumed to be substantially
1456 the same as the water pumpage. Under sewage treated

are given the actual flows from the plant records, as in Illinois Exh. 26, except that in 1940 the 7-month average is used. The figure of 878 m.g.d. given for 1940 is misleading, in that the treated flow rose from 696 m.g.d. in January to 1032 m.g.d. in May and fell to 988 m.g.d.
1457 in July. The estimated flow of sewage in the Sanitary District at present (September, 1940) is approximately 1070 million gallons daily. Of this, about 82 m.g.d. is untreated. The untreated sewage was steadily reduced throughout the first seven months of 1940. Part of the untreated flow is from the Kostner Avenue sewer area on the West Side. The connection therefrom to the Sanitary District interceptor is under construction. The balance if accounted for by other miscellaneous flows from Clearing, Argo, parts of Blue Island, Posen, Oak Forest Institution, Evergreen Park, Mt. Greenwood, and other small situations. The figure of 82 m.g.d. is current, say July, if you prefer. It may vary from
1458 month to month. It is about 8 per cent of the total.

1458-1459 To supplement Illinois Exh. 24, the dry solids removed over seven months average daily—

Plant	Tons per 24 Hours
Calumet, new	30.2
North Side	106.6
Southwest	187.5
West Side	73.1
TOTAL	397.4

1460-1461 Illinois Exh. 50 shows the yearly record of sludge and grit removed at the sewage treatment works from 1929 to 1940, except that in 1940 only seven months were used. The sludge is calculated from the actual volume removed, knowing the per cent of solids.

No sludge has been discharged to the channels of the Sanitary District from the West Side Plant at any time. From the Calumet Works there was sludge discharged in 1936, 1937, and 1938 during the tuning-up of the sludge handling equipment. From 1929 to 1939 inclusive, most of the sludge piped from the North Side Works was emptied into the Main Channel at Stickney. This sludge included the excess activated sludge and the sludge from the preliminary settling
1462 tanks at the North Side Works. Its water content varied from about 99.8 to 98.9 and is usually over 98.5, and very watery. At first but little sludge was run into the West Side Works for digestion, but in 1931 and 1932 a considerable portion, around 25 per cent, was run in, but ownig to its volume, the digestion capacity available proved inadequate. From 1933 to 1935, only 14 per cent of the North Side sludge entered the West Side plant. During 1936, through 1937, less than 8 per cent. In 1938, only 2-½ per cent. In 1939 and 1940, one per cent or less entered the West Side Works.

1463 The tonnage in Illinois Exh. 50, column 8, represents the sludge caught in the plant. It shoots up rapidly in 1939, with the plant going into service. The last column represents the tonnage discharged to the channels of The Sanitary District. The discharge was greater in 1939 than theretofore. The table shows what is retained
1464 in the plants and what was lost. There was a substantial reduction in the sludge to the channel in 1940, compared with 1939. There will be a more substantial reduction when the new filters are in service at the Southwest Works.

1465 In Illinois Exh. 49, in 1939, the last column shows 377 m.g.d. That represents untreated sewage. The 53,970 tons shown in Illinois Exh. 50 for the year 1939 comes from the 670 m.g.d. of sewage, shown under sewage treated, because that tonnage is the excess which we were unable to dispose of on land. The figures 377 and 53,970 cannot be added, because the latter is tons per year and the former is million gallons per day. They are different units.

1466 To the 377 m.g.d. of sewage would be added the average daily volume in gallons per day of the 53,970 tons per year.

1467-1468 Illinois Exh. 51 shows the amount of sludge discharged to the channel in tons per year for 1929 to 1939, and for 7 months in 1940.

1469 The table shows the disposition of the North Side sludge, and the sludge to the channels of the Sanitary District. The tonnage to the channel from 1929 to May 23, 1939 was largely derived from the North Side Works.

When the Southwest Works went into service on May 23, 1939, an accumulation period occurred for a few weeks, in which activated sludge was built up. By September, the sludge dewatering and drying began. At times the amount handled built up to over 200 tons of dry solid per day. Most of this was shipped away for fertilizer. The dried excess not shipped was burned. The sludge not handled was discharged to the Main Channel from the Southwest Works. In the spring of 1940, after the Racine Avenue Pumping Station was cut in, the solids from the preliminary tanks were diverted to the West Side Works for digestion.

1470 The table shows what came from the North Side, grit by railroad to the dump and sludge by pipeline. Under disposal is shown the distribution of the sludge, whether to the West Side, Southwest, or Channel.

As the Southwest Plant came in, some of the Nor h Side sludge was put into the Southwest and dewatered. More or less, but continuously sludge from the North Side, from 1929 on, went to the Main Channel. The largest amount was 38,394 tons in 1938. Sludge from other sources reaching the Channel is shown under Calumet and Southwest.

1471 Up to the end of 1935, the Calumet plant was an Imhoff tank plant, with a couple of experimental units of activated sludge. No sludge went into the channels from the Calumet plant during the operation of the Imhoff tanks. In 1936-1937-1938, during the tuning-up period, excess sludge was discharged to the Channel. For a time a lagoon was operated on the excess sludge but it produced so much odor, which was commented upon for a half mile or more, that we decided, with the diversion we had then, to discharge the material into the channel. It was not a great addition over the amount already going in from the North Side Works. The odor was cut down. Apparently there was very little difference in the channel. The Southwest Works went into service in 1939. Sludge was discharged.

1472 The grand totals correspond with those read from Illinois Exh. 50.

1472-1473 Illinois Exh. 52 shows the record of sludge handling in tons per month from the North Side and South-
1474 west Works from July, 1939 through July, 1940. For each plant is shown the total tonnage, and its disposi-

tion, distributed to the West Side, Southwest drying
1475 and channel. Under the final disposal is shown the total tons to the same points. The material from the Southwest to the West Side digestion is the sludge from the preliminary settling tanks at the Southwest. It was desirable to keep this out of the material used for fertilizer on account of the grease content and its unchanged character, not having been through the activated sludge process. The peak discharge to the channel was 6,435 tons in October, 1939. Thereafter there was a steady decline to 1866 tons in July, 1940. That figure is somewhat under the average monthly discharge for the first seven months of 1940, calculated from Illinois Exh. 50 and 51, which show the total for the first seven months.

1477 The West Side plant is a digestion plant. The digested solids are taken from the tanks, air-dried, and run out on our railroad to the sludge dump. At no time have they ever gone to the channel.

1478 The West Side treatment is a partial treatment, to remove by settling whatever will settle in around two hours. There is a removal of B.O.D. around 50 per cent, and approximately the same of suspended solids. Ramey has estimated the additional plant needed to bring the effluent up to the quality of the Southwest plant. There is material in the effluent of the West Side plant that is untreated, except for such part as was
1479 settled out. The material in the effluent is not included in these tables. Such material is classified as part of the sewage which went through a sewage treatment plant. We can compile the amounts of such material for you from the operating tables.

1480 The effluent of the West Side plant now contains a considerable percentage of untreated matter. Eventually the West Side will have an effluent as good as the activated sludge part of the Southwest Works. At present the sewage in the Southwest Works only receives partial treatment. The tables were prepared to inform the Opponents on the technical data requested, not so
1481-1482 much to inform the Master. Illinois Exh. 53 shows for 1938 the tonnage per month of sludge and grit at the various works of the District, with the disposition thereof.

1483-1484 Illinois Exh. 54 shows for 1939 and 1940 the tonnage per month of the sludge and grit from the various works of the District and the disposition thereof.

1485 These two exhibits are breakdowns of Illinois Exh. 50, to show monthly data. For general purposes back of 1938, we felt the yearly records were sufficient.

1486 Under the heading "Channel" is a record of sludge that came out of a plant as a result of sewage
1486-1487 treatment. In 1939, the sludge removed was finally disposed of as follows:

Method of Disposal	Tonnage (Dry Solids)
Digestion	28,110
Main Channel	53,970
Dried by Heat	23,782
Grit to Dump	3,061
TOTAL	108,923

These figures are taken from Illinois Exh. 54 but are summarized in a different form.

The drop in efficiency in the Southwest Works in 1940, followed the period of January, February and

March when all the flow handled went through the entire plant, that is, the preliminary tanks and the activated sludge. From April to date, a part of the flow in varying proportion, has been given only preliminary
1488 treatment by settling. This appears to be due to the explosion in one of the boilers in January, which put two units out of service, because two of the heat-drying units are connected to one line of breeching to a single stack. This cut down the available capacity for sludge drying. It seemed better, early in April, to remove by preliminary settling whatever sludge could be settled for digestion in the West Side Works, and while repairing the heat-drying units to discharge the excess settled sewage to the Main Channel, over what could be treated by the activated sludge process to sufficiently load the heat-drying apparatus.

We discussed emergency lagoons, but in the light of our experience at Calumet with lagooning activated sludge, we felt it was better to turn the sludge loose in the channel.

1489 The chief difficulties in tuning-up have come from the lack of adequate air compressors and adequate dewatering and heat-drying equipment. These lacks are chargeable to inadequate funds prior to 1940.

The boilers turned out too much steam generating capacity. Owing to the hookup in pairs on each stack, if repairs are needed, two units of heat-drying have to be shut down. This is being remedied. The changes in the drying equipment are practically completed (September 9, 1940). The blower capacity has been too low from the start. Three additional blowers are
1490 under contract, each of 100,000 cubic feet per minute

capacity. The additional filters under contract are arriving in installments and will be in operation before the end of the year. Some slagging has occurred when sludge is burned in the boiler furnace. The fusion of mineral matter in the sludge may occur if the furnace temperature goes too high. This has required attention to the operating end, to train the men. If molten slag were to fill the ash pit, the usefulness of the boiler setting might be destroyed.

1491 The remaining reason is that because of inability in the earlier months of 1940 to make a budget, we did not know how much money we had to spend in operation. This resulted from the uncertain taxing power of the District for corporate expenses. The Sanitary District had requested a special session of the Legislature. It was delayed. The trustees desired to make the money in hand last as long as possible before shutting down the plant, if the worst came, and the legislature was not called in special session or failed to act. For the first five months of 1940, we were up in the air, and after the first three months economies were enforced to keep down use of power and coal. Luckily the Legislature came to our relief. We were able to go ahead, continue operation, and develop.

1492 A special act was passed in 1940, increasing the ability to tax for corporate purposes, to serve the operation of the plants and works in the District. It is a taxing power to raise operating money. It enabled the issue of temporary certificates.

1493 I will furnish the record of air used at the North Side Works from October 3, 1928 up to 1930.

Cross Examination by Mr. Naujoks

1629 At the North Side Works, from October to December 1928, 0.97 cubic foot of air per gallon of sewage was used, and in 1929, 0.8 cubic foot per gallon.

1630 My duties are general. I collaborate with Dr. Mohlman on many questions of operation and investigation. I take up questions in connection with the design and operation of the works. I pass on right of way matters. Such a position might be styled Consulting Engineer. I have no assigned duties to be done each day. I prepare opinions for the Engineering Department, our Chief Engineer, and the Legal Department. I was a witness before the Special Masters Hughes and McClennen.

1631 An explosion in the furnace setting of a boiler at the Southwest Works shut down two units in the dewatering and drying end of the sludge handling and restricted the handling of the sludge, and thus interfered with the operation of the works.

1633 There are two sources of sludge, one from the North Side through the pipeline, the other, excess sludge from the Southwest Works. These are mixed. Whatever the conditioning, filtering, and heat-drying apparatus can handle is heat-dried and shipped out in box cars as fertilizer material. The excess, due to lack of capacity caused by the shutdown for repairs, was discharged to the Main Channel. About April 1, 1940, the preliminary solids, which had theretofore been handled with the activated sludge, were put into the West Side Works for digestion. This improved the quality of the fertilizer

material and removed grease, which was higher in the preliminary sludge.

1634 The repairs are practically complete. The practice of not treating all the sewage completely at the Southwest Works during 1940 originated in the troubles such as the accident in the boiler. We were fearful our money might not hold out to operate into June or until such time as the Legislature would give relief. The
1635 operating department decided to by-pass the portion of sewage whose sludge could not be heat-dried and sold and put the preliminary effluent into the Main Channel. To complete the sludge handling, eight filters are under contract to increase the present 24 to 32. These should be in service by the end of 1940. In the boiler repairs, the connections to the stacks are being rearranged to give flexibility so only one unit can be shut down, instead of two at a time. The blower capacity is inadequate at present to continuously carry 400 m.g.d. Three blowers, each of 100,000 cubic foot per minute are under contract. One blower will be delivered in 18 months, all in two years. At present the Southwest Works is underblowered, because our money did not go far enough to buy sufficient blowers for the nominal capacity of 400 m.g.d. The PWA Board
1637 cut out one blower and left us three. I believe the bids were taken within the last three months. Deliveries are difficult to obtain because of the competition with the United States, which is buying such equipment for use in the manufacture and testing of aeroplanes.

1638 The contracts were let as soon as possible after the report made by the PWA Review Board. The present equipment does not furnish sufficient air for the com-

plete treatment of all the sewage at the Southwest Plant. The figures on Illinois Exh. 50, 51, 52, 53, and 54 are expressed in pounds of dry weight, in one case computed from the removals of suspended matter by
1639 the plant, and in another from the sludge measurements. It is possible they will not entirely cross-check. In the sewage field it is difficult to reconcile sludge weights with suspended matter. The North Side pipeline has a flow capacity of 2.5 m.g.d. and operates at a fairly uniform rate. The density has varied around 98-½ per cent water.

1640 The problem of cleaning the pipeline is before us, to restore its capacity. From the Standard Saturation tables of the American Public Health Association, the dissolved oxygen in Lake Michigan water may be around 8.1 p.p.m. in the summer and up to 14 or 15 p.p.m. in the winter.

1641 The winter conditions in the waterway are better than in the summer, although conditions were not satisfactory in January, 1939, following the cut in diversion. The dissolved oxygen dropped to zero at Lockport, which is very unusual. Conditions continued unsatisfactory in the winter and early spring, even with a high dissolved oxygen in the lake. There was less trouble in the 1939-1940 winter than in the previous winter.

1642 The chart (Rec. 258) shows on monthly averages some dissolved oxygen in January, February, and March of 1940. In April, 1940, the dissolved oxygen was exhausted. The B.O.D. in 1940 were lower than in 1939. My general impression is that conditions were better in the winter of 1939-1940 than in January to March, 1939.

1643 The introduction of oxygen tends to reduce the B.O.D. somewhat. However, under existing conditions, the increase in oxygen may have little practical value, depending on how it is done. With B.O.D. running up to 25 to 30 parts per million in 1940 and 40 in 1939, it would be difficult to obtain sufficient oxygen without
1644 increasing the diversion. At the North Side Works, the B.O.D. removal in September, 1929, attained 97.2 per cent. That was the maximum reduction in B.O.D. in that year. The average removal for the year 1929 was 95 per cent of the 5-day B.O.D. in 1928, the air used was 0.97 cubic feet per gallon of sewage. In 1929, 0.8 cubic feet per gallon was used. In 1930, air in amount 0.52 cubic feet per gallon was used and removal of B.O.D.
1645 of 92 per cent was attained. In 1931, a removal of 92.6 per cent of B.O.D. was obtained. In 1932, a removal of 91.7 per cent of B.O.D. was obtained with 0.41 cubic feet of air per gallon. In 1933, a removal of 88.3
1646 per cent of B.O.D. was obtained with 0.37 cubic feet per gallon. In the later years a good effluent was obtained with a lower use of air, around 0.4 cubic feet per gallon, than formerly, with as good an effluent. In such degrees of treatment and amounts of air, a slight difference in the amount of air does not make much difference in the reduction of B.O.D. In the exhibits from 1936 to 1937, the air averaged 0.36, 0.35, 0.36, 0.37 cubic feet per gallon, with a reduction of B.O.D. of 91.5 or 92 or 92-½ per cent. The reduction of B.O.D. is lower in winter, and greater in the summer. Little is gained by using more air, because nitrates are produced, which are of little value in our ultimate result. We are trying to keep dissolved oxygen in the flow at all times, where-

as nitrate oxygen does not become available until the dissolved oxygen is exhausted. In the earlier period
1647 more nitrates were carried than now, yet the present effluent is practically just as good. The use of more air would not duplicate the result of 1929, because that was obtained with a period of aeration of 7.2 hours on a reduced flow and now the period is around 4.5 to 5 hours. There is an element of time in the period of aeration, as well as the amount of air.

1648 The use of more air without an additional aeration period would not do much good. Nitrate production by the activated sludge process does not do enough benefit to warrant the expense. This is the trend in many of
1649 the large activated sludge plants in the United States The making of nitrates by the activated sludge process is not an efficient use of public money. Additional air will make a little more nitrate in the effluent, but the nitrates do not become available until the dissolved oxygen is exhausted. Then you are at the point of nuisance. The small amount of oxygen in the nitrate is unimportant. It is best to keep up the degree of treatment through the entire system of the Sanitary District.

The nitrate content is not a common index of stream condition. The first index is the dissolved oxygen, because some must be present in order to avoid a nuisance
1650 in the absence of sludge banks. Nitrates in a stream may be a detriment. Some of the older sewage plants in the United States produced 10, 15, or more parts per million of nitrate. The nitrate encouraged the propagation of plants, algae, and the like, which die and make a nuisance. Nitrates may produce a secondary nuisance worse than the conditions created by the raw sewage

before a treatment plant was built. Nitrate forms in the Illinois Waterway as the flow nears Peoria as part of the purification cycle.

The condition of the Illinois Waterway above Peoria
1651 for a number of miles is good. There is at least 3 or 4 parts per million of dissolved oxygen. Fish have moved up the river and commercial fishing is practiced up to Ottawa. From the standpoint of the dissolved oxygen test, the river is in good condition. We do not analyze for nitrate because we do not consider that test of value. I have no data on the content of nitrite and nitrates in any stream the size of the Illinois Waterway with reference to nuisance.

In the Calumet area, the Calumet River flows out into Lake Michigan at South Chicago. Near 130th Street,
1652 it forms two branches, the Grand Calumet and the Little Calumet. The Grand Calumet runs easterly to Gary. The Little Calumet runs southeasterly, passing the controlling works of the Sanitary District at Blue Island. The Sanitary District endeavors to keep the flow in the Calumet River out of and away from Lake Michigan. There is another outlet to Lake Michigan, in East Chicago, the East Chicago Ship Canal. The Grand Calumet River receives the flow as high as 600 c.f.s. of condenser or cooling water from the steel mills in Gary. Most of this runs into Lake Michigan through the East Chicago Ship Canal, carrying the pollution of sewage from Gary, part of East Chicago, Hammond, and part of Whiting. Current meter tests show a flow west-
1653 ward into Illinois around 30 to 40 c.f.s. The menace to the Chicago water supply is the discharge of untreated sewage at East Chicago. In Illinois the sewage

has been picked up along the Calumet River within the Sanitary District, except for part of Blue Island. Certain pickling liquor wastes are also discharged direct to the river, as unfit to enter the treatment works. These are a relatively small part of the pollution with the present dilution. The flow from Indiana into the Calumet-Sag Channel is from 40 to 50 c.f.s. Mr. Howson states the Gary plant went into operation about September 1, 1940. With the completion of the Gary and Hammond plants, a small load will still come from Indiana into Illinois.

1655 The final solution of the Indiana situation in the Calumet region depends on the proposed arrangements of Controlling Works or Locks by the United States in the proposed widening of the Calumet-Sag Channel. The Snaitary District has suggested two Controlling Works —one in the Calumet River, the other in the East Chicago Ship Canal, so no flow goes to the lake. This would require the steel mills to reverse their condenser water back to the lake instead of discharging into the Calumet River, unless the United States permitted the condenser water to be taken in addition to the allowed diversion. The Sanitary District has not consented to such flow. The decision of the War Department is awaited. Whatever the Indiana towns may do in sewage treatment is welcomed, both from the standpoint of the channels and the effect on the Chicago water supply.

1656 Lemont discharges raw sewage into the Main Channel, but is planning treatment works. Lockport discharges into Deep Run, as does the Texas Company, entering the Waterway about half way between Lockport and Joliet. The flow of Stateville Prison goes to the

Des Plaines River. The flow of the old penitentiary may enter the river below Brandon Dam. The treatment of any sewage entering the Waterway above Joliet from municipalities, industries, or state institutions will improve conditions by the amount of pollution removed, although a very small proportion of the whole.

1658 The sewage at the start of the Calumet plant contained a great deal of acid pickling liquor waste from the steel mills, foundries, and others, where acid is used to clean the product. There is also a paint mill, with varied wastes. The pickling liquor interefered with the operation of the plant by introducing ferrous iron,
1659 which oxidized in contact with the air and created a deposit in the surface of the diffuser plates. The pressure built up rapidly, so each tank had to be drained and the plates cleaned every two weeks. At the request of the Sanitary District, practically all these industries have diverted or transported all such waste direct to the river or Calumet-Sag Channel.

1660 The diffuser plates have not been used as long as those on the North Side. Further cleaning may be required. Certain industrial wastes may have interfered with operation. Rather than handle one waste, the producer moved that department from Chicago. We are
1661 trying to operate the Calumet Works to the highest degree and eliminate whatever interferes.

The B.O.D. removal at the Calumet Works has at times exceeded 92 per cent. During 1940, the average B.O.D. removal for the first five months was 91.3 per cent. With the additional capacity available, a longer period of aeration with a greater amount of air per gallon of sewage might produce a somewhat higher grade effluent. Whether the additional aeration would aid in

removal of B.O.D. is a question. The nitrification might be greater. The B.O.D. might be reduced perhaps one part per million.

1662 I will examine the procedure referred to in the Budget Report on Engineering Work for the Sanitary District of 1940, on page 53, and see what caused the better reductions of B.O.D., with an increase of air rates and somewhat higher concentration of solids in the mixed liquor. Apparently the record shows around 83.5 to 86.9 per cent in the summer months and a jump in November to 92.2 and in December to 91.

1663 I assist in the preparation of the Budget Report in a general way. I would want to check up and see if I approved that particular statement in its entirety. I have prepared a record of the nitrates and nitrites, and air in cubic feet per gallon for the various works from

1664 1928 to 1940. The results for the Southwest Works are on the activated effluent alone.

1665 (Pearse Cross Exam. Exh. 1)

1666 I do not recall the amount of oxygen in a pound of nitrate. Dr. Mohlman states that there is 0.47 pound of oxygen in a pound of nitrate, the relation being 80 to 170. That is the available oxygen.

1667 The West Side Works provides preliminary treatment only in Imhoff tanks. The amount of sewage handled in those works is given by the exhibits. I will look up the amount of the West Side sewage run through the Southwest Works each month.

1668 I will also obtain how much load the Southwest Works can now assume. In January to May, 1940, the West Side Works removed a little less than 50 per cent of the B.O.D. The June and July averages brought it

up around 50 per cent. No chemicals are added. The addition of chemicals would increase the treatment, but not to a removal of 75 per cent.

1669 In our tests the removal did not go much above 60 per cent. I assisted in the investigations in a general way. Dr. Mohlman directed them. I took the final data and worked up the Report of April 16, 1940, with the aid of the others who signed it.

1670-1671 Assuming the B.O.D. in the raw sewage at the West Side averages 100 parts per million, the final effluent without chemicals averages 57 parts per million and with chemicals 36 parts per million, the difference (21 p.p.m.) on a flow of 450 m.g.d. represents an equivalent population of 444,000.

If the raw sewage of the West Side area was settled in Imhoff tanks and chemicals applied so as to reduce the B.O.D. from 100 to 36 parts per million, this would amount to increasing the treatment of approximately 440,000 people.

1672 The addition of chemicals to the West Side Works would improve the effluent by removing organic pollution, and so cut down the amount of B.O.D. in the Pool. The amelioration of the Pool is subject to the effect of the sludge deposits. I listened to Andrew's testimony and cannot tell to what degree the dredging he proposed would change conditions in the Pool. Apparently his method of measurement does not reach the material Dr. Mohlman and I classify as sewage sludge. The sludge determined by Andrew is very dense and not the lighter sewage sludge. If this dense material were removed, the conditions in the Pool would be much the same. I doubt if he could remove all the material classi-

1673 fied as sewage sludge. The removal of the denser material, unless an obstruction to navigation, is a very speculative benefit, and so is any dredging that I can conceive. Sewage sludge around 90 per cent moisture
1674 content is hard to drain off a relatively flat floor. If the Pool were emptied, a lot of the sludge material would flow out. How much is hard to say, as I do not know the relation of the outlet of the Pool and its bottom depths. I do not believe he can drain it out short of actual pumping. When draining, there will be 2,000 or 3,000 c.f.s. running in all the time. Doubtful if anyone would advocate running the Chicago River into the Lake to drain and sweep out the Pool at Joliet.

1675 Dredging is impractical and will accomplish little unless it is in removal of actual obstructions to navigation. I doubt if much of the sewage sludge will be moved which has a demand for oxygen and is decomposing for two or three years in the Pool. It is intensely speculation. I would hesitate many times before spending the public money on such a venture.

1675 The time for an organic deposit in a stream to finally decompose and become inert is not thoroughly determined and may run from three to five years. It is a question of the decomposition of the organic material in the mass. Andrew is working on the question of removal of deposits which are essentially inert, but may contain some organic material. He wants to remove physical material in the deeper layers. We are looking to the removal of a body of more or less liquid stuff which would flow, if it would drain down, relatively slowly. It is not solid or liquid sand. It has a very effective demand for oxygen.

1676-1677 Our studies on the Illinois Waterway show a double demand from sludge deposits in the Waterway, coming partly from the sludge coming contemporaneously and partly from the prior deposits and from the winter deposits. Stream cleaning the Joliet Pool is very speculative as to whether it would accomplish any practical result unless to remove an obstruction to navigation which is caused by material, some or a good portion of which may never have come from a sewer.

1678 If the liquid material went out of the Pool it would create a demand for oxygen in the lower regions of the Pool and transfer the complaints from Lockport and Joliet to points below. There would also be odors from the exposed surfaces, and complaints from shippers if navigation were stopped. I conclude that pulling the Pool down and doing some housecleaning is utterly impractical. Material is removed from Imhoff tanks at moistures as low as 90 to 87 per cent. In settling basins of the old type, with very flat bottoms, men are used with rubber boots and squeegees to shove the sludge along with the aid of fire hoses.

Andrew could move some of the border line material. The bottom material is relatively dense, but he says he

1680 cannot walk on it. Over the dense material is material of increasing fluidity, maybe 6, 7, 8 per cent solid. Ever since I joined the Sanitary District staff, I have discussed cleaning waterways, with the late Mr. Wisner, the cleaning of the channels. We came to the conclusion that trying to clean a waterway of such material by dredging is very impractical. In Chicago, the Health Department would not permit disposal in the lake. At Joliet, it would be necessary to pump the material to

a lagoon, where it would decompose and create odors.
1681 This would shift the trouble from one spot to another. If the money were spent in the treatment works of the Sanitary District to speed up the work, it would be better.

The District expects to discharge less and less material to the Waterway, until eventually, with complete treatment, a small residual is reached of relatively light suspended matter, perhaps 5 or 7 per cent of the total. It will move a long way, but should not tend to form a dense sludge. The final result is entirely different from the summer of 1939.

1682 If no more sludge were put into the Waterway the difficulty in Brandon Pool will gradually lessen. In two or three years the people down there will forget all about the Pool, from the odor standpoint. An additional diversion in the summer months would be helpful in sweeping along the gases and products of decom-
1683 position out of the Pool. That is why conditions were supportable prior to the cut in diversion.

1685 How the suspended solids can be moved out of the Brandon Pool, and how much can be moved, I do not know. I therefore do not know how much you could ameliorate the condition in Brandon Pool. Of course, on a hypothetical basis, if you moved all the solids from that Pool to the next, you have improved conditions. I do not know a practical way of moving the solids. I doubt if a dredge with constant pumping, and stirring the Pool would do much good. I am skeptical as to whether opening the gates at Brandon Dam at time of flood would scour to a practical degree. Probably only

1686 a very small limited scouring would occur, with no effect a half mile away.

The movement of sludge close to the dam is inconsequential when talking about a Pool say four miles long from 200 to 1400 feet wide. I heard Andrew testify that the way he measured material there was no deposit about Jackson Street in the Brandon Pool. I did not understand he testified there was no sludge. He is careful to qualify what he describes. I am talking of one thing. He is talking of another. What he
1687 measures is by a disc with an 8-pound weight on it. He and I are not on the same premises. I doubt if opening the gates in winter at the Brandon Dam would scour the Pool. I doubt if you can stop navigation. In some winters, navigation is almost continuous.

In the effluent of the Sanitary District plants there will be some suspended matter. The effluent of a
1688 well-operated activated sludge plant contains some suspended matter. At the North Side Works in 1939, 7.6 per cent of the suspended solids went through. Such residual will tend to settle as sludge. However, such solids are light and will eventually settle only after traveling many miles. Not knowing how much suspended solids Chicago drinking water contains, I cannot tell whether a well operated activated sludge effluent contains less. I do not know what you mean by an average clear stream. I know what a trout stream would look like and I know what the Mississippi River looks like, or the Ohio.

1690 I admit the parts per million of suspended matter shown in our plant records in the effluents. An acti-

vated sludge effluent is relatively clear, with colloidal floes in it.

1690 I have not drunk any Chicago water. I have filtered water at Winnetka and spring water at the office. I avoid Chicago water because it has a chlorine taste. I would be surprised if Chicago city water contained as much suspended matter as an activated sludge efflu-
1691 ent, except on a windy day.

It is possible to dump chlorine into the West Side plant and prevent odors from the plant and sterilize the
1692 bacteria. Such chlorination would be a wasted effort, so far as doing any real good in the Brandon Road Pool.

There is no complaint of odors from the plant.

Examination by the Master:

Chlorine is not applied in any of the major plants of the Sanitary District to the sewage or effluent. We regard chlorine as a means of sterilizing may be justified if sewage is put into a drinking water supply. At Cleveland, the plant effluents have been chlorinated in the past, also at Milwaukee. But such effluent goes into the drinking water.

In our situation no one uses the Illinois River for drinking water in its length of 310 miles. There is no need of destroying the bacteria which are to serve in the useful work of self-purification of the stream.

1693 Chlorine is applied to the Imhoff tank effluent before discharging upon the trickling filters, at Glenview, Morton Grove and Northbrook, to keep down plant odors in the summer time. It is not introduced per se for the

1694 effect on the stream below. Chlorine does not fit in the Sanitary District picture. It does not get rid of organic matter. It delays decomposition to a point where the effect is exhausted. Then the same nuisance starts over again. The flow is then freed from the restraint of chlorine and decomposition proceeds actively. If chlorine were soaked in to restrain decomposition for miles the cost would be impractical.

At the Southwest Works the sewage is rather stale in the summer. A slight odor is noticeable from the preliminary tanks. Inside the dewatering and drying building there is a peculiar odor from the handling of sludge,
1695 but it does not go beyond the building. There is practically no odor from the aeration tanks. We are always watching the preliminary tanks. Chlorine is used at the Southwest Works to maintain clean surfaces in the condensers. Chlorine is introduced into the condenser water to prevent the growth of slimes on the outer surface of the condenser tubes, and prevent loss of efficiency. This is good practice, which is followed by the Commonwealth Edison Company in its generating plants. In general, there are no odors from our plants as such. Once in a while there is some odor from the drying operation at the Southwest Works. There are
1696 other sources of odors from industries in the vicinity of the West Side Works, such as the American Tar Works with a very distinct phenol odor. Chlorine will reduce the B.O.D. apparently. Thus the application of one part per million will reduce the B.O.D. by about 2.4 parts per million temporarily. But from the standpoint of the ultimate removal of the organic matter I do not admit that it does any good. Such reduction

is not permanent in a stream and may wear off in the
1697 travel of a mile or two. In a corked bottle, if sterilized
1698 the result might be permanent, until uncorked and re-seeded. On the Illinois Waterway problem where the organic matter must be disposed of, chlorine would delay decomposition and merely transfer the nuisance somewhere else down stream. The cost makes a proposal to chlorinate the stream fantastic.

1699 Cross Examination By Mr. Naujoks

If all the bacteria are killed in an effluent and it is sealed in a closed container, it will stay so indefinitely. If the effluent is put in a stream bacteria come in. There is no way of reaching a permanent controllable situation. I know of no stream exactly sterile.

The B.O.D. reduction in an effluent that has been chlorinated is not permanent. For the purpose of the test decomposition of the organic matter has been delayed. But the organic matter causing the B.O.D. has not been destroyed. That is my understanding of the process. I was the editor of a book, entitled "Modern Sewage Disposal". I was not the author of all the articles contained therein nor do I guarantee their correctness. The quotation on page 160, from the chapter on "Chlorine in Sewage Practice" referring to some
1701 tests of Rudolfs and Gehin does not shake my opinion. I do not know the conditions under which their tests were made. Enslow quoted certain tests in that article. What the conditions were, I do not know. Some have claimed as on page 106 of Modern Sewage Disposal that

with only a partial satisfaction of the chlorine demand, a substantial reduction of the oxygen demand may be expected. I have never examined this myself to determine the exact picture of what really happens. I am thinking of what would happen if our effluents or the channel were chlorinated to improve the Illinois River. I adhere to my statement or opinion.

1702 I have practically no experience on the breakpoint on chlorine demand in water purification or its application to sewage treatment.

The effluent of the North Side Works picks up dissolved oxygen in flow to the North Shore Channel. The effluent of the final settling basins drops down some 15 or 16 feet in its flow to the North Shore Channel, passing over steps to dissipate the velocity. In its flow the dissolved oxygen is increased from 1½ or 2 parts per million to 6 or 7 parts per million. The cascading effect is produced by the design, originally built to dissipate

1703 the hydraulic head without damage. The liquid picks up dissolved oxygen in amount depending on the degree of de-oxygenation.

It is possible to install cascades at the Stoney Gates in the Canal above Lockport. When the old Bear Trap dam was in existence, and flow was run over it, there was a pickup of 4 or 5 parts per million of dissolved oxygen. The water appeared to pick up more, but did not hold it. The residual was seldom over 5 parts per million. Whatever is picked up is of value to meet B.O.D. but at no time could we pick up to saturation. The Bear Trap dam has since been removed. If the gates were opened there would be some re-aeration.

Cascades at Lockport might restore some dissolved oxygen to the flow, but it would be only a very small proportion of the B.O.D. arriving at Lockport.

I do not recall an exact figure for B. Coli in raw sew-
1705 age as I am primarily interested in the bacteria. Sometimes half a million are present per cubic centimeter, or one million or several million. We are not primarily concerned with destroying bacteria.

The flow discharged over the dam at Lockport would pick up dissolved oxygen, as described for the old Bear Trap dam. The width of the crest of the two small dams
1706 is less than the width of the old Bear Trap dam. Such oxygen as is picked up may amount to 4 or 5 but seldom 6 parts per million. The dissolved oxygen at the North Side Works may run up to about 85 per cent of saturation in the summer, as shown in August and September of 1939 with 7.2 and 7.8 p.p.m. as against perhaps a saturation value of 8.5 p.p.m. Neither Dr. Mohl-
1707 man or I are entirely satisfied that all of such oxygen is able to give us full service. We report what we find.

If the additional sewer were constructed to directly connect the West Side effluent into the Southwest Works, this would provide increased treatment within the limits imposed by the installed blower capacity at
1708 the Southwest Works. Whether a better overall treatment would be secured, I will explore and report.
1709 There would be no value in building such a sewer if the plant cannot take the flow. It is possible to give activated sludge treatment up to the blower capacity available and discharge to the channel any excess activated sludge which the heat drying apparatus cannot handle.

1710 Maybe if such procedure had been followed we would have been better off. The preliminary solids would be taken to the Imhoff tanks for digestion. The Chief Engineer of the Sanitary District decides what
1711 is to be done. If we had shown a lower B.O.D. there would still be a lack of dissolved oxygen to meet it. The excess sludge cannot be dumped on spoil banks. It would run off. As to lagoons, we tried a lagoon at Calumet during the tuning up of the sludge drying plant. It produced the only odors we have had at Calumet. The odor was traceable a mile away. Complaints
1712 came in. We are doubtful as to how satisfactory a lagoon would be.

If a scum is formed, maybe the odor would be less. Activated sludge alone is a very peculiar digesting material. Such excess material could be pumped West of Harlem Avenue but the Lagoons might create another nuisance. Lagooning would cost money, better expended in permanent improvements. The chlorina-
1713 tion of a lagoon would be speculative. Indianapolis has operated lagoons for years in a sandy soil with success. Our soil is heavy clay, very poor draining. The installation of elaborate underdrains and appurtenances would add to the cost and lengthen the time
1714 required. The excess sludge could be dewatered on vacuum filters. Vacuum filters cost money. There are eight on order. If the additional filters are installed by the First of 1941, we should be able to handle the tonnage from the North Side and Southwest Works. The efficiency varies, but has not come up to our
1715 expectations, despite elaborate preliminary tests. The West Side sludge is digested and air dried on the open

airbeds some 30 acres in extent. At no time has the Sanitary District dumped any sludge from the West Side Plant into the Channel. The effluent is sewage partly treated. It contains residual suspended matter after the Imhoff tanks have removed 60 per cent of the suspended matter. The West and Southwest plants have interchanged flow of sewage. As far as sludge is concerned the West Side Plant is separate, except that preliminary settled sludge from the Southwest Plant is dumped into the West Side for digestion. In the Southwest Plant the excess activated sludge which cannot now be dried is dumped into the Channel. With the additional filters and the repairs and alterations in the first of 1941 the Southwest should be able to care for the excess activated sludge originating within it. In addition provision must be made for the sludge to come from treating the West Side effluent.

The plan is to mix the West Side effluent with the Southwest sewage. To the excess activated sludge, the North Side sludge is added. At present the North Side sludge is mixed with the Southwest sewage and is aerated with it.

The Southwest Plant is not physically able to treat 400 million gallons daily, because of lack of blower capacity.

The major problem from the monetary standpoint is supplementing the West Side Works. The minor problem is building up the Southwest Works, so that when combined with the West Side effluent there is sufficient air and sufficient sludge handling all the other equipment required to complete the job. This

will take two and one-half years, and should be done by the end of 1942.

There is the finer problem of tuning up and enlarging where equipment is scanty to handle the normal 400 million gallons per day at the Southwest Works.
1720 Whether it is desirable to build the sewer from the West Side Works to the Southwest at this time, I will ascertain. Ramey suggests it as part of the final future improvement, whereas Mr. Naujoks wants it immediately for doing more work on the West Side effluent. Ramey indicated it would add to the work now on hand, which is plenty, and I raise the question whether the Southwest Works has enough aerat-
1721 ing capacity now to care for the West Side effluent if the sewer were built. I will figure this out, as well as the ultimate hydraulic capacity of the Southwest Works as it now is. I have the impression that its hydraulic capacity is insufficient to take the entire
1722 flow of both the West Side and Southwest sewers. I will check the PWA report.

1723 The cause of the trouble in Brandon Pool goes back to the closing of the Brandon Dam in 1933. This caused a pool and stopped a rapid flow through Joliet. The sewage solids came down in large degree as the sewage treatment was limited to the Imhoff tanks at Calumet and the West Side, and the activated sludge plant at the North Side, with its sludge discharged to
1724 the channel at Stickney. The trouble comes from the sewage from the Chicago area. There are several elements. The deposited solids of previous years from the population and industry. The untreated sewage and the currently deposited material. In the older

days around 1919 with the raw sewage going in the
1725 flow swept the material down river. The time of flow was shorter to Joliet. Today it is longer. The solids 3 or 4 years old are relatively digested. Each year the solids are becoming less. It is possible to say whether the partly treated West Side effluent is more important than the excess sludge from the Southwest plant.

1726 We have never determined the B.O.D. of the discharge of the sludge pipe line.

1728 Cross-examination by Mr. Naujoks

1729 I will check up on the hydraulics of the Southwest Works and see if the entire West Side and Southwest flow can be put through it.

1730 On the tests, the detention period was 1.45 hours and air at 0.18 cubic feet per gallon, with an average B.O.D. reduction of 89.5 per cent. That result was obtained on settled sewage. If raw sewage and preliminary settled are mixed, I would not expect to attain the same result.

1731 The detention period in the Southwest aeration tanks is 5 hours. The design basis was for an average flow of 400 m.g.d. and a maximum of 600 m.g.d. The present flow is shown on the sheets given you. In some cases it has been below 400 m.g.d. The aeration basins may be planned on the 5 hours for the 400 million, but the blowers and other equipment are not adequate to take what comes if you handle that volume.

1732- The flow in August through the Southwest Plant
1733 was 340 m.g.d. At no time during 1940 has 400 m.g.d. flowed through. In August, 167 m.g.d. received complete treatment, in the preliminary clarifiers, aeration tanks, and final settling basins. The clarified effluent is
1734 173 m.g.d. The Sanitary District intends to run through the Southwest plant not only the sewage from the Southwest area, but as much more as can be fed in from the West Side, as soon as the plant is tuned up.

1735 I doubt if all the sewage from the West and Southwest can be put through the present plant.

If there is the flow of 400 m.g.d. from the West Side and 340 m.g.d. from the Southwest, there may be theoretically sufficient capacity to provide two hours detention in the present aeration tanks. I have my doubts whether any such flow can be put through the plant hydraulically. The arithmetic may be correct but the conduits may not be large enough.

1736 Neglecting the hydraulic capacity or the ability of conduits to convey flow, the paper calculation shows that there would be sufficient capacity to provide about two hours detention for the combined West and Southwest areas. However, there will be an additional flow before the end of the year of about 40 to 50 m.g.d. from Kostner Avenue and miscellaneous connections.

1737 The dry weather flow of both plants will be somewhat over 800 mg..d. and less than 900 mg..d. Kostner Avenue sewer now (September 11, 1940) discharges to the channel, but will be picked up before the end of 1940. The flow is about 40 to 50 m.g.d. The pickup will help ameliorate conditions in 1941.

1738 At present there are three blowers installed, each with a nominal capacity of 60,000 cubic feet per minute. One is kept as a spare, so the present capacity generally operated at the Southwest Works is 120,000 cubic feet per minute. I will figure out how much that is in cubic feet per gallon, and also what happens with two blowers and three, also on 400 m.g.d.

1739 Activated sludge is material derived from sewage by repeated actions of aerating the sewage in the presence of the sludge retained from previous operations. The exact action of the sludge is a question of debate between biologists, chemists, and physicists. After 10 to 20 days of operation, a plant should develop a sludge with the power of purifying the sewage. The activated sludge has a clarifying power when mixed with sewage kept in suspension and supplied with adequate air. When settled, a fairly clear liquid results, with a small amount of suspended matter. The activated sludge acts on the organic matter present and reduces the B.O.D. and transforms the organic material in so-

1740 lution into more or less permanent form. If carried far enough, considerable nitrate can be developed, as shown by the original experimenters, Ardern and Lockett, who developed nitrates without regard to the efficient use of air, as high as 10 or 15 parts per million. Present day operation is to stabilize the organic matter and reduce the B.O.D. markedly and not develop more than one or two parts per million of nitrate. My conception of the process is that the action is

1741 largely biochemical. The sludge contains volatile and mineral matter in varying amounts, a little phosphate, and a little potash. On our case, the mineral or ash

may run around 40 per cent. The volatile may run from 60 to 70 per cent. At Milwaukee, the volatile runs up to 80 per cent. The sludge also contains a number of bacteria of various types, of which some are nitrifying. Others aid in clarification. The exact composition in terms of carbon, nitrogen, and other chemical components, I do not know. I have never seen a detailed analysis on that basis. Upon the proportionate balance of the volatile and the mineral matter depends the behavior of the plant, as well as on the type of micro-organisms present in the sludge.

1742 The sludge from our final settling basins may run as high as two per cent solid matter, or from the operating standpoint, 98 to 98½ per cent moisture. Sometimes the moisture in other plants is as low as 97 per cent. It settles in a cylinder in perhaps 30 minutes, to about 20 per cent of its original volume. Some days it does better, others worse. It is not a stable sludge. It has putrefactive possibilities, with a demand for oxygen. The sludge is returned as promptly as possible to the incoming sewage, so it may return to the oxygen supply.

1743 The North Side plant has aerated channels connected to the return pumps. In the Southwest Plant, the return is made directly by air lifts. We have never determined the oxygen demand of that sludge. I have
1744 no figure in mind. However, I believe I can present an estimate of the population equivalent of 53,970 tons
1745 of dry sludge discharged to the canal in 1939. I am pretty sure I cannot produce any such figure as 1,500,000 people. 53,970 tons is the total to the channel from all sources, not the North Side Plant.

1746 I do not say the figure of 1,500,000 population is in line with anything. I was trying to correlate it with the North Side pipe line, where the solids come from 1,000,000 people. I would naturally expect that the solids coming out would not have the equivalent population of the sewage that originally went in.

1747 Raw sewage is the liquid coming out of a sewer, varying in composition, depending on the type of sewer, separate or combined. The raw sewage contains solids. The total solids in suspension and in solution may range anywhere from 350 to 600 or 700 parts per million. Of those solids, a part is suspended matter. The suspended matter plus the finely divided colloidal matter determine the amount of sludge taken out of the sewage. Colloidal matter, roughly, is material so finely divided that it does not readily settle in a few hours.

1748 If sewage is settled in the Imhoff tanks of the West Side, the sludge is chiefly derived from the suspended matter. There is very little colloidal matter taken out compared to the removal in the activated sludge plant. The sludge producing ability of the plant is measured by the amount of suspended matter removed, which shows as solids recovered as sludge. There is digestion in that sludge, so that the sludge actually removed from the drying beds will be less in dry weight than what was actually deposited in the tanks. In the Imhoff process, there is a 3 to 6 months digestion of the organic matter, so that about 50 per cent of the orig-
1749 inal organic matter deposited is lost. This loss on digestion varies. The dry solids removed from the beds are less than the solids deposited in the tanks,

because of digestion. In the activated sludge plant, there is the coagulation or clotting of the fine particles produced by the prepared activated sludge as well as the settling action. The liquid after settling, aside from the residual suspended matter, is almost as clear as lake water. There is a certain removable suspended matter. Each day there is an excess taken out of the activated sludge plant when it has arrived at its proper operation, which is approximately the amount of the suspended solids. There is reason to believe there is some reduction in the amount of solids coming in, but not any such digestion as occurs in an Imhoff tank. Starting with the sewage, and largely, but not wholly from the suspended matter, you remove solids, either directly by sedimentation or by the addition of activated sludge and final settling.

1750 These solids, mixed with water from the sludge, which in the activated sludge may run from 98 to 99½ per cent moisture, or in the Imhoff tanks around 90 to 92 per cent moisture. 98 per cent water and 2 per cent solids, compared with 90 and 10, shows a remarkable concentration. One sludge is 49 water to 1 of solid, the other, 10 water to 1 of solid. To remove the water in activated sludge, we use ferric chloride to coagulate the sludge, followed by a vacuum filter. That is different. The Master saw it on the trip.

1751 I would not attempt to say whether in the activated sludge process with an overall removal of some 90 per cent of the B.O.D., about 30 per cent is by oxidation and 60 per cent by bio-precipitation. I have not speculated on the division of the process. I have been working on the overall removals. By analogy and

not for exactness, I believe a large per cent of the reduction of B.O.D. in the activated sludge process is accomplished by precipitation of the suspended solids. Comparing the results in the settling tank with the activated sludge plant, there is the average figure reported to the U. S. Supreme Court of 33-1/3 per cent removal by the settling process. Actually, in the West Side Plant we attained 48 to 50 per cent removal. That is primarily due to settling, with whatever coagulation occurs as the particles sink. In the activated sludge
1752 plant, the removal of B.O.D. reaches 90 to 95 per cent. This additional purification is attained by reason of employing the activated sludge process. I am interested in the overall accomplishment. I have not speculated on the part due to aeration and mixing and to final settling. To the extent that the sludge discharged to the Main Channel has B.O.D., it nullifies the effect of the benefits accomplished at the North Side in making a high-grade effluent. There is a beneficial effect in the flow of well treated effluent through the heart of the city.

1753 On the completion of the West and North Side interceptors, from the North Side Works to the entrance of the South Fork at Bridgeport, we have tried to have no raw sewage or sludge dumped in. We did have a certain amount of industrial waste in that stretch. Until last April, we had most of the Stock Yard waste coming in at Bridgeport.

1754 There is a residual benefit effect of the treatment given the liquid. We have no exact determination of it. We never put any sludge into the North Shore Channel from the North Side Works. The pipeline

was in operation at the time the plant went into service in October of 1928.

1755 The effect of old sludge on the North Shore Channel and North Branch depends on the timing. North of Fullerton Avenue, the interceptors were completed by the end of June, 1930. That was later than the opening of the North Side Works. The West Side Intercepting sewer system was not completed until a later date. Until rather recently there was sewage entering the North Branch from Fullerton Avenue south.

1756 After the sewage was intercepted, there was still the effluent and some sludge material from various industries, which had an effect on the stream. The City and the District have cooperated to divert the effluent of industries from the river to the City sewers or the District interceptors. For quite a while after the North Side Works were in full service, there was the effect of old sludge.

The Sanitary District has never made any B.O.D. analysis of the Activated sludge. It has no B.O.D. analysis of the sludge out of the pipeline. We do 1758 not make such an analysis as part of our routine work.

Assuming no further sludge is deposited in the Illinois Waterway beginning January 1, 1941, the older the sludge deposits in the Channel are the less the B.O.D. exerted. In so far as that tends to lessen the amount of putrefaction in the Brandon Road Pool it tends to improve conditions. Whether it would improve them in the next year or two to a point of entire satisfaction in the community, is a question.

1759 As the material digests, the gasification decreases and the B.O.D. exerted is lessened. That tends to improve the conditions in the Pool. Whether these conditions will improve sufficiently before the West Side Plant effluent is finally treated, is a question. I have my doubts as to whether they would be sufficiently improved until that effluent receives final treatment by activated sludge. There would be material deposited, the difference between what is taken out of the Imhoff tanks and what will be removed by activated
1760 sludge. There is undoubtedly a tendency to improve conditions.

Theoretically, if you use a chemical coagulant in the West Side plant, you improve the effluent. You would improve it still more if activated sludge were added. To go at chemical coagulants, takes both time and money. The Report to the PWA Board shows it cannot be done simply. Contracts must be prepared and let. It would take from 1½ to 2 years. That was why we recommended to our Chief Engineer that the District go ahead and install the supplemental activated sludge plant at the West Side. We are spending our money for a permanent purpose to get the highest effluent for the benefit of the people down below. We did not believe that by using chemicals we could obtain as good an effluent or as permanent a solution,
1761 or as cheap a solution, on the comparative estimate. We saw no hope of quickly obtaining relief by adding chemicals on the scale that we had to work. To add chemicals to 400 m.g.d. means a fairly permanent type of installation. Eventually it would have to be scrapped because it would not produce the grade of

effluent (on our tests) that is necessary to meet the conditions that we expect to meet in trying to carry out the request of the Supreme Court. We told the Court we expected to deliver an effluent treated 85 per cent or better. We did not see how it could be done by chemicals.

1762 To add chemicals to the influent of the West Side Works requires equipment for handling and storage of chemicals, contracts, construction. If you are looking for something that you can say today I want done tomorrow, you cannot do it by chemicals. You cannot do it by anything short of turning the water on. The chemical method would take one to two years. In the meantime, we can install activated sludge, which will do a better job, and fulfill what we told Mr. Hughes we would do.

1763 I see no need of the control of odors by chlorine locally at the West Side Works. There was no necessity to chlorinate to protect a water supply by destroying bacteria. We saw no value in adding chlorine under our conditions because it would not cure the conditions, probably in the Brandon Pool.

I do not know what is meant by the term "chlorinate the effluents." There are various degrees of chlorination.

1764 I see no value in sterilizing the effluents so no bacteria are present. I understand chlorine has been used in moderate amounts for various purposes of control in trickling filters and sludge digestion, but I would not say it has not interfered with the biological action. Many experimenters discuss how far you can go before you injure the biological action. Moderate

amounts have been used. We add chlorine to the effluent of the three small sewage plants of the District for the control of odors, yet there is biological action in the filters. Chlorine has been added to the returned activated sludge in an attempt to control bulking. Some users have worried that if too much were added the
1765 bacteria might be destroyed. The point I have in mind is that chlorine as a means of curing the nuisance in Brandon Pool does not fit. If I try to sterilize the whole flow so it passes through the Pool in a state of arrested decomposition, the time element is such that it seems very impractical. Partial application of chlorine is not particularly helpful on account of the amount of B.O.D. to be overcome, if you assume that by the application of chlorine you can remove the B.O.D. The exact extent is a moot point. I testified as to my theory the other day.

I have made no tests whatever as to sludge in the Brandon Pool. I have endeavored to ascertain the depth of sludge in the channels of the District on several occasions. As far back as 1910, sludge deposits existed above Lockport in the fore bay up to the old controlling works, as much as 8 and 10 feet deep near the Power House.

1766 At the old controlling works there was 2 or 3 feet. Through the rock cut with the high velocities then prevalent, there was practically no deposit. We tried to find deposits with a little dredge and with bottles. In the wide full section of the Channel we found some deposits. The velocities in the Channel today are much lower. In the rock section, with 2,500 c.f.s. discharge at Lockport, the velocity is about 0.7 foot

per second and may go lower. We now have deposits in the rock section, which makes a B.O.D. exerting area.

1767 From observation of Brandon Pool on several occasions when gas boils came up, I conclude there must be light sludge in such a pool. This is confirmed by the reports of our chemists. Andrew limited his observations to material determined by the permanent position of a 10-inch diameter sheet iron disc with an 8 or 10 pound weight on it. From our knowledge of sludge and trying to measure sludge in tanks and elsewhere, Andrew's test defines only compact material at the bottom. There is certainly lighter sludge above it, becoming lighter as the thread of the flow is reached. Andrew is talking about material obstructive to navigation. His line of demarcation may very properly be below a lot of the material, which we are speaking of, that boils up.

1769 If 6 to 10 feet of sludge were removed from Brandon Pool, the depth of the Pool is increased. I have no knowledge of the depth of the Pool. I have made no soundings. It is not in the control of the Sanitary District. Any new deposits would seek the bottom of the excavated Pool. Any gas from decomposition
1770 would have to pass up through a greater depth of water and a greater volume of water than exists today, or a greater cubic volume of space. If more flow were added, the conditions would be ameliorated. I do not know just how much gas can be absorbed. Probably as much gas would come out, whether the Pool were 10 feet deep or 16 feet. A greater flow would wash the gas away. Then there would be less coming to the

atmosphere, because there is greater displacement at
1771 all times. This would be more effective than digging a deeper hole.

The material defined by Andrew is different from the sludge Mohlman and Pearse have in mind. Andrew is talking of the denser material with the lesser amount of organic matter. Dr. Mohlman and I are worrying about the more liquid material containing the greater part of the organic matter. Andrew cannot pick up all the material by the use of a dredge. He proposes to use a cutter head, necessarily in the more dense material. He will pump a larger volume into a large pool, which will discharge an effluent into the stream down below.

1772 He may transfer part of the nuisance to his lagoon or pool. How much that will ameliorate the nuisance is doubtful. I believe the money could be better spent on blowers or filters or something of that sort.

In January, February, and March, 1940, all the sewage entering the Southwest Plant received activated sludge treatment. The flows ranged from 197 to 287 m.g.d. From April on, about fifty-fifty up to September, 1940, except for June with 235 m.g.d. through the preliminary process only, and 130 m.g.d. through the
1773 activated sludge. In August, 340 m.g.d. were treated, of which 164 m.g.d. received preliminary treatment only. For the five months April to August inclusive, the average flow not receiving activated sludge treatment was 162 m.g.d. I will compute the population equivalent.

1774 The removal of B.O.D. by the preliminary tanks at the Southwest Works on the short period of settling

is around 20 to 25 per cent. This I will check. I will determine also the population the increased treatment would be equivalent to if all the sewage receiving preliminary treatment were given the activated sludge treatment. I will consider it with our inability to handle the sludge, and also for the future with sludge all handled.

1775 I will calculate the oxygen made available by 3500 c.f.s. additional lake water in pounds per day and how many people this flow would satisfy the B.O.D. of.

From my tests on the Bear Trap Dam years ago, we introduced from 2 to 4 parts per million of dissolved oxygen into de-oxygenated flow in the Canal. I doubt if a cascade built there would increase the dissolved oxygen up to 6 or 8 parts per million.

1777 I doubt if deoxygenated liquor of that kind can actually be saturated with oxygen in any reasonable time by cascading. I have tried to do it but could not. There is no need to build a cascade at the Controlling Works. Just lower the controlling dams at the Power House and shut off the flow through the turbines. With some 42 feet of crest, and the drop to the tail race, a nice cascading effect is produced. This may put in 2 to 4 parts per million of dissolved oxygen.

1778 I do not think this would cure the condition in the Brandon Pool. With the B.O.D. exerted last year and this summer the oxygen would be gone before the flow reached the Pool. If you wish to avoid a nuisance, some oxygen must be present. There is no practical place to reaerate today. You cannot get enough oxygen in under those conditions.

In the old days there was the old Economy Light dam, with a small amount of reaeration when water did not go through the water wheels. In the Eddy report to the Board of Review, there is shown a large amount of oxygen taken in down through the Joliet stretch of the river, because of the high velocity, the exceeding turbulence, and the thorough mixing at a time in the summer months when the flow at Lockport was deoxygenated. At Marseilles, the oxygen was all gone again.

If the wheels at the Lockport Power House were stopped, there would be a cost to the District to purchase the equivalent power now generated at Lockport. I do not recall what the purchase price for power is under the contract. Ramey can tell.

1780 Oil on the surface of a pool or in our activated sludge tanks does interfere to some extent with reaeration at the points where the oil film exists. I have seen very little spots of glistening oil on my trips on the Canal and Pool recently, but not a remarkable amount of oil. For a stream serving upwards of 4 million people, there is remarkably little floating occurrence of that kind.

1781 I do not know how much oil enters the Waterway from the Texas Refineries. The State of Illinois has been using its utmost to have all floating material retained. I have the impression the Texas Refineries have been consistently successful in retaining such material and were retaining such material several years ago.

If the flow of sewage can be reduced, obviously on a fixed design, the more sewage you can put through.

The effect of universal metering in Chicago on the sewage flow is very problematical. It is a problem whether universal metering is possible or will be at-
1782 tained. I have never felt that in our calculations universal metering could be reckoned on as a factor. Universal metering might reduce per capita flow somewhat. The amount is very speculative. The effect of metering in the last seven or eight years, in a population with little change, is negligible. The treatment works and sewers are not designed on a universal metering basis. About 28 per cent of the services are actually metered. The City has shown no disposition
1783 up to date to completely meter the flow. Whatever the PWA Board said about the effect of metering on sewage treatment facilities is in the record. Whatever effect metering may have, if it reduces the per capita flow, will prolong the useful life of the works or enable better results to be obtained.

1784 In the North Side Works, the flow has held steadily around 200 m.g.d. for the last ten years, with certain variations. I do not yet know what the exact population on the area is at present. It probably has increased but little. It is largely built up with apartment houses, with many meters. Whether the District can get down to 200 gallons per capita per day for its entire sewage flow is very speculative. The metering program is very much in the future, and moves slowly. The District will take advantage of any capacity it gains.

1785 In 1939, the per cent of water services metered in Chicago was 27.9 and the per cent of water metered

was 37.56. The number of services decreased roughly 10,000 from 1930 to 1939.

1792-1793 The metering required of the City by the U. S. District Engineer permit of March 3, 1935, was never carried out. This shows that it is rather difficult to have complete metering installed in Chicago. From 1930 to 1939, the number of meters increased from 85,846 to 115,000 out of a total number of services in 1930 of 422,066, and in 1939, of 412,228. The rate of

1794 increase averages 3,000 meters per year. On that basis, with 300,000 meters to be installed, it would take 100 years. In my position, I figure that while metering will come and will benefit the Sanitary District, it is not a very immediate factor which has any bearing on the current improvement of the Brandon Pool. The Sanitary District has no control over metering, which is a function of the City of Chicago. I do not know to what degree metering can be accellerated.

1795 If a reduction in water use were effected in Chicago by metering, it would tend to make slightly more capacity available in the intercepting sewers and treatment works for storm water. Universal metering, if it reduce the flow, would make available a little more capacity for storm water in the intercepting sewers

1796 and treatment works. Any reduction in flow by metering would affect the flow at Lockport and reduce the amount of power developed, and also the amount of water available for dilution.

The report was made to PWA on April 19, 1940. On May 3, 1940, the PWA Board made its report. Consideration had been given the supplemental works for

the West Side effluent many months before. Ramey will tell you when the first steps were taken.

1799 At the request of the Chief Engineer, he took the original report sent to the PWA Board and assembled the facts from the various departments. I then prepared a rough draft, which was reviewed by the men who signed the final report, of date April 19, 1940. A second draft was made, which was filed with the Chief

1800 Engineer. This was forwarded by him to D'Esposito, who referred it to his Board, which had requested such a summary of the proposed plan of the Sanitary District. That Board was composed of eminent engineers, including Mead, who was an excellent hydraulic engineer. The Report of April 19, 1940 was accepted, with some reservation as to the rapidity with which the work should go ahead. The Board thought we should delay a bit. I advised going ahead, buying the equipment, and completing the plans. With the money available, we are going ahead on the complete job. We had three or four sessions, in which Ramey, Johnson, and Mohlman joined.

LANGDON PEARSE

Cross Examination by Mr. Naujoks

2520 In answer to the question asked by the Master (Rec. 1465-1466, Illinois Exh. 50 shows 53,970 tons of dry solids discharged into the Main Channel in 1939. This is from two sources, the North Side and the Southwest Works. The excess sludge from North Side in 1939 totaled 39,213 tons of dry solids, in a volume of 693.5 million gallons. Of this, 34,776 tons of dry

solids went into the Main Channel. The dry solids content as originated was 1.34 per cent. The volume of the sludge was 1.9 million gallons per day from 202.5 million gallons per day of sewage. From the Southwest Works the sludge discharged in 1939 only from July to December inclusive was 19,194 tons of dry solid. The amount and moisture content varied each month.

2522 I have prepared a table (Pearse Cross-Exam. Exh. 1, Rec. 2523) to show each month the tonnage of dry sludge, the volume of sludge, the volume of sewage from the North Side and Southwest Works ,the volume of sewage from the North Side, West Side, and Southwest Works, the discharge at Lockport, and the flow at Summit, all in million gallons per day. For instance,

2524- the 192 tons of dry solids per day is contained in

2525- 4.22 m.g.d. of liquid. The percentages of moisture

2526 content were between 98 and 99 per cent. On the North Side pipeline the dry solid content averaged 1.34 per cent. The solid is represented by dry weight. If it is 2 per cent, the water is 98 per cent, which gives the volume. The tonnage of 192 with a volume of 4.22 million gallons per day, went into a volume in the Channel at Summit of 1,303 million gallons per day.

2528 An additional flow enters the Main Channel between Summit and Lockport from the Calumet-Sag Channel.

One million gallons per day is equal to 1.54 cubic feet per second.

2529 A discharge at Lockport of 1862 million gallons per day would be about 2850 c.f.s. This includes both sewage and sludge.

2530 If sewage is aerated for a longer time in our aeration tanks and more air is used, there is a better reduction of B.O.D. and a larger generation of nitrates. Doubling the air will not double the nitrates. In 1929 at the North Side, with 0.8 cubic foot of air per gallon and 7.2 hours detention, the yearly average showed a removal of B.O.D. from 115 down to 5.6 parts per million, with 5 parts per million of nitrate in the
2531 effluent. In 1933, with 0.38 cubic foot of air per gallon, and 5.4 hours detention, the B.O.D. was pulled down from 122 to 14 parts per million, with 2.3 parts per million of nitrate. With half the air, we had less than half the nitrates, with a slightly higher B.O.D. in the effluent, and a detention of 5.4 hours instead of 7.2 hours. In 1939, with 0.37 cubic foot of air and 4.7 hours detention, the B.O.D. was pulled down from 117 to 7.7 parts per million, with 0.7 parts per million of nitrate. The 1929 result would cost twice as much for air as the 1939 result.

2532 At present the flow is 200 million gallons per day, on an average of nine years. The longest period we can now obtain is 5.5 hours. The period of 7.2 hours is out of the question. In 1934, with 5.4 hours and 0.38 cubic foot of air per gallon, the final B.O.D. was 14.1 with 2.3 parts per million of nitrate. In 1931, with 5.2 hours and 0.47 cubic foot of air per gallon, the final B.O.D. was 8 parts per million, with nitrates 2.2 parts. In that comparison, a slight increase of 0.09 cubic foot of air did not increase the nitrates, but did reduce the B.O.D. somewhat.

2533 In a rough way, it is possible to figure for a plant the amount of air required to remove 1,000 pounds of

B.O.D., without regard to nitrates. Ignoring cost, the conclusion is that with an increase of air per gallon of sewage, the removal of B.O.D. is better and the nitrates are probably higher in the effluent.

2534 An additional 25 per cent of air in 1931, over 1934, reduced the B.O.D. from 14.1 to 8 parts per million.

2535 The plant may not have been operated on exactly the same basis, as considerable experimentation was going on. With more air, within certain limits, a better effluent is obtained. The showing made by these comparisons as to the production of nitrates is rather inconclusive, when you try to pick how much air must be used to produce a definite amount of nitrate. There appears

2536 to be no way of calculating. Only a test will show. The production of nitrate in our plant is not an economical venture.

At the Southwest Works, the following dates are submitted:

Pumping began (from West Side)	
Preliminary tanks only in use	May 23, 1939
Activated sludge started	June 9, 1939
First battery in service	June 27, 1939
Second battery (half service)	Sept. 6, 1939
Second battery (full service)	Oct. 26, 1939
Southwest Interceptor cut in up to Western Avenue	Sept. 7, 1939
Dewatering and incineration began	Aug. 7, 1939
In continuous use	Aug. 28, 1939
Racine Avenue Pumping Station—	
Partial pumping to Southwest	March 20, 1940
Complete flow to Southwest	May 2, 1940

2537 Prior to March 20, 1940, the Racine Avenue Pumping Station flow went directly into the South Fork of the South Branch of the Chicago River, and entered the Main flow just above Damen Avenue, or Robey Street.

2538 I have prepared a table showing the connection of 29 sewers to the Southwest Interceptor.

2539 PEARSE CROSS EXAM. Exh. 2.

These connections were made between June, 1939 2540 and May, 1940. The flow is estimated. The table shows the number of sewers, the estimated dry flow, and the cumulative dry flow. The total dry flow on the Southwest Interceptor is estimated at 325 million gallons per day. The flow has varied.

2542 In May the pumpage at the Southwest Works was 2543 310 m.g.d.; in August, 340 m.g.d. The pumping may include some flow from the West Side system, or some rainfall. Apparently in August the figure, corrected for the West Side, would be 335 m.g.d. That exceeds 325. The sewers are designed on a general basis of carrying 150 per cent of a dry weather flow. The de- 2544 sign dry weather flow is considerably over 325 m.g.d., probably over 400 m.g.d. The capacity of the intercepting sewer is probably over 600 m.g.d., as I recall, about 1100 c.f.s., or, roughly, 750 m.g.d. This is far in excess of the average dry weather flow.

2545 The capacity of the Southwest plant was nominally 600 m.g.d., or 900 c.f.s. If more flow comes than the plant can treat, the excess could be diverted direct to the river, or if the interceptor filled up, backed out through the city sewer outlets. Those are two safety valves. There are also the limitations of the hydraulic

capacity of the plant, and the pump capacity. The de-
2546 sign covers the broad situation. It is our intention to carry a flow through the plants up to 150 per cent of the dry flow during a storm. Beyond that, the excess spills to the river. In some few cases more sewage has
2547 been carried in an interceptor. There is also the question of what happens to the sewage not picked up. There are some 350 municipal sewers which discharge to the various rivers or channels in the District. The intercepting sewer picks up a certain proportion of the flow from those sewers. If exceeded, the excess goes to the stream. This is in time of storm. The regu-
2548 lators are inspected almost daily to see that material does not escape in dry weather.

I am correcting my testimony on the blower contract (Rec. 1636) for the Southwest. The contract for three blowers was entered into on August 29, 1940. One blower is to be delivered on or about May 1, 1941. It should be in operation by August 1, 1941. The other two units are to be delivered on or about March 1,
2549 1942, and should be in operation by October 1, 1942. Each blower unit has a capacity of 100,000 cubic feet of air per minute.

2550 I will make up a statement of the results with the new equipment installed, to give a picture for the summer in 1941 and 1942.

LANGDON PEARSE

Cross-Examination by Mr. Naujoks

2555 The blower contract was awarded to the Allis-Chalmers Manufacturing Company of Milwaukee, Wisconsin.

The two Illinois State Prisons at Joliet both discharge raw sewage into the Waterway. The old prison is located just outside of Joliet to the south and east of the Waterway. At one time it had an Imhoff tank, which has since been abandoned. The new prison at Stateville is two miles north of Joliet, to the north, and west of the Des Plaines River. This discharges into the Des Plaines River just above its junction with the Waterway. Negotiations are pending for the discharge of the sewage from both prisons into the Joliet sewers. The sewage of Lockport, with a population of about 3,000, enters Deep Run, which discharges into the Illinois Waterway about ¼ mile below the Power House. The outflow from the Texas Company also enters Deep Run. The plant is equipped with settling basins for retaining sludge and skimming oil. Lockport is planning sewage treatment.

The sewage of Lemont, with a population of about 2,500, enters the Main Channel without treatment. Lemont is planning for sewage treatment and has requested the Sanitary District to lease it a site. Financial aid is asked of the WPA.

The Joliet sewage discharges into the Waterway below the Brandon Road Dam. If the prisons arrange with Joliet to receive their sewage, the discharge, whether treated or untreated, will be below the Dam. It is an advantage not to have such sewage in the Pool.

The population of Joliet is 41,936 for 1940, as compared with 42,993 in 1939. At Ottawa the population was 15,938 in 1940, and 15,094 in 1930. Peoria had a population in 1940 of 105,003, as compared with 104,968 in 1930. The Census releases show populations for

cities over 10,000. I will attempt to obtain the population of all the towns along the Illinois River.

2563 With reference to the use of air at the Calumet Works (Rec. 1661-1662), I examined the plant record
2564 for 1939 and 1940. I present Pearse Cross-Exam. Exh.
2565 3 showing monthly averages for air, suspended solids in mixed liquor, iron, per cent iron in returned sludge, aeration period in hours, B.O.D. in effluent in parts per million, and per cent of raw, sludge index, nitrites, and nitrates from January, 1939, to August, 1940.

2566 The sludge index is the milliters of volume occupied by one gram of sludge solids. It is determined to indicate the settling behavior of a sludge. If the index is under 100, the operator seldom has to worry.

The table (Pearse Cross-Exam. Exh. 3) shows the air at Calumet was steadily reduced in 1939 to 0.29 cubic foot per gallon in July, with a lower mixed liquor solid content in June of 2720 parts per million, and in July of 3040 parts per million. The air was increased to 0.35 cubic foot per gallon in September and held through October, with mixed liquor solids around 3100 p.p.m. In November, the air was increased to 0.52 cubic foot per gallon and the mixed liquor solids ran up to 4310 p.p.m. The B.O.D. in the effluent went down to 8 p.p.m.

2567 During the summer the air used proved too low. The operator increased both the air and the solid content of the mixed liquor. In December he dropped back to 0.43 cubic foot of air and obtained a 91 per cent reduction of B.O.D., an effluent of 10 p.p.m., B.O.D. and nitrates practically at 3 p.p.m. as against 3.2. Thus almost as much nitrate was obtained with less air. The

nitrification was practically the same in November and July of 1939, but the air used was 0.52 cubic foot per gallon in November and 0.29 in July.

2567-2568 By taking figures at random from a table like this (Pearse Cross-Exam. Exh. 3), I can easily prove that less air produced more nitrates. Plant operation must be studied by and large. In June, July, and August of 1940, a lower or equal residual B.O.D. was obtained 2569 with less air than used in February, 1940. The fluctuation in nitrates is irregular and not in constant ratio to the reduction in B.O.D. In July, 1939, the nitrates were 3.3 p.p.m., whereas in August they dropped to 0.8 p.p.m. with a slight increase of air. Probably the air in July, 0.29 cubic foot per gallon, was too low. The operator did well in July at the expense of the sludge. In August and September he 2570 had to refresh the sludge and continued to increase the air. In November he speeded up.

I did not produce the table to show I could make 2571 more nitrates with less air. I produced it to show the difficulty of determining from the operation of a well controlled plant what the underlying causes were. In 2572 general, more air means more nitrates and better reduction of B.O.D., up to a point where the air becomes wasteful. The longer the period with the more air, 2573 the better the results. In operation, a low residual of B.O.D. is important, rather than merely a percentage reduction. We are seeking to keep down the B.O.D. in the plant effluent.

2574 The per cent of reduction depends on the strength of the sewage. With a sewage containing 100 p.p.m. B.O.D., with 90 per cent removal, the residual is 10

p.p.m. With a sewage containing 200 p.p.m. B.O.D., a 95 per cent removal is required to give 10 p.p.m. residual.

2575 The hydraulic capacity of the Southwest Works from preliminary basins to the plant outfall is 750 million gallons daily. This cannot be utilized for sewage treatment under present conditions because the installed pump capacity is inadequate. The total discharge capacity of the four pumps installed is 780 m.g.d. With three units running, only 600 m.g.d. can
2576 be attained. The probable load factor is 75 per cent. The present installed capacity of the air lifts on the activated sludge return system limits the sewage flow to 600 m.g.d., with 30 per cent return. The final settling basins now installed are planned for an average flow of 400 m.g.d. A poorer effluent is expected at 600 m.g.d. The present air supply may prove inadequate. I assume the flow to be handled at the Southwest
2577 Works is limited to 600 m.g.d., and that the Southwest flow is 325 m.g.d., and the West Side 475 m.g.d. If 600 m.g.d. be taken through the Southwest Works, 275 m.g.d. will be diverted from the West Side, which has left 200 m.g.d. The estimated analysis of the sewage mixture entering the Southwest Works is 170 p.p.m. suspended matter and 135 p.p.m. B.O.D. The North Side sludge is kept out of the aeration circuit.

If the preliminary tanks remove 30 per cent of the suspended solids, 119 p.p.m. remain. If the effluent contain 40 p.p.m., then 79 p.p.m. are retained, or 395,000 pounds. For convenience, this is taken as 200 tons. Adding 100 tons from the North Side, the total 300 tons per day of total dry activated sludge solids is

2578 available for disposal. The preliminary sludge of 128 tons per day is diverted to the West Side plant. At present (September 26, 1940) 24 filter units are installed at the Southwest Works. Only 18 can be relied upon for constant service. In the warmer months, a rate of output around 1.5 lb. of dry solid per square foot of filter area per hour is attained. This amounts to 184.5 tons per day. In the winter, a rate around 2 lb. per square foot per hour is attained.

After the 8 filters now under contract are delivered and installed, there will be 32 on the floor. Of these, 24 will be available. At the 1.5 pound rate, the possible output is 246 tons per day during the warmer months. This leaves a difference of 300—246=54 tons to be disposed of. The easiest point is the Main Channel. Additional filters will require time and becomes part of the permanent plan.

2579 Assume 50 per cent removal of the suspended solids from the West Side sewage produces 48.5 tons of dry solids daily. The solids sent to the West Side from Southwest are 128 tons daily. The total is 176.5 tons per day to be digested. It is questionable whether the present West Side Imhoff tanks can handle the additional tonnage of preliminary solids in the winter months. The sludge drying beds are inadequate. They can only average from 68 to 85 tons per day per year. There is thus an excess of 33 to 50 tons per day per year to be disposed of, or 14,000 to 18,250 tons per year.

This sludge should be kept out of the Channel because of its density. Three methods of handling are available:

Additional drying beds; lagoons; and filtration after dosing with lime and iron salts.

Any one of these takes time. The relative merits require investigation.

2580 The three blowers now installed have a combined capacity of 180,000 cubic foot per minute. These cannot run continuously as some time is required for inspection and repair. The auxiliary air required at low flows is 21,200 cubic foot per minute. With one blower only, 38,800 cubic foot per minute is available for the aeration tanks. At 0.5 cubic foot air per gallon, this would handle 112 m.g.d. With 0.2 cubic foot, 278 m.g.d. With two blowers running, the auxiliary use is estimated at 34,000 cubic foot per minute. This leaves 86,000 cubic foot per minute for the aeration tanks. At 0.5 cubic foot per gallon, this cares for 284.8 m.g.d., or at 0.21 cubic foot per gallon, 600 m.g.d. can be aerated. With three blowers running, 146,000 cubic foot per minute is available, which provides at 0.5 cubic foot per gallon, for 416 m.g.d., and at 0.35 cubic foot per gallon, for 600 m.g.d. At 600 m.g.d. and 30 per cent returns, the aeration period
2581 is 3.2 hours. The settling rate in the final tanks is 2000 gallons per sq. ft. per day. This would produce an effluent probably containing around 40 p.p.m. B.O.D., with a uniform load. With the variations in load expected and the cramping of the air supply for maximum daily loads, the exact results are in doubt.

2582 In a hearing of a popular nature before a congressional committee in 1925, I was contrasting the relation between a high-grade effluent and a settling tank

effluent, and in so doing I indicated that the effluent of a well operated activated sludge plant might be
2583 clear, stable and odorless, and that fish life might be maintained right at the plant. In the intervening 15 years, I have learned that while a fairly clear effluent can be made as shown in our plants, there is a certain amount of suspended matter in it. There is a certain amount of B.O.D. and of dissolved oxygen. If the flow period was from 30 minutes to an hour, under certain conditions such a flow could be introduced into a stream. What I said in 1925 does not bind me today (September 26, 1940). I admit the words, but I do not admit the implications. The effluent comes out of the North Side Works containing about 8 to 9 p.p.m. of B.O.D., with 7 to 8 p.p.m. of dissolved oxygen. It flows down the North Branch
2584 and in its flow, during a period of 16 to 24 hours, it may lose all its oxygen. These changes occur. Time is an important factor. I do not tell anybody that such an effluent is harmless. It is odorless; relatively clear at times; contains some suspended matter; contains organic matter which needs oxygen. In a flow from Damen Avenue to Lockport, during a period of about 4-1/2 days, there is a very different picture from the original statement. With all the present facts in mind, I do not admit the correctness of the quoted statement as applied to the present analyses of the situation here.

2585 The effluent of an activated sludge plant is odorless; it is clarified, being fairly clear but containing suspended solids maybe 6, 8, 10, 14 p.p.m., or in wet weather, even more. It is stable within the degree

of oxygen that is there to meet the B.O.D. However, the conception of stability today is different from 1925. Then we thought of methylene blue stability test, which is now largely discarded, because it meant little. Stability today is measured by the amount of oxygen present as against the oxygen demand. On paper, the North Side effluent looks stable because at times the effluent shows more dissolved oxygen than
2586 B.O.D. It may not be so if all the dissolved oxygen in the effluent does not stick. As to fish life, the situation is this. At the outlet of a plant and for a distance below, until the oxygen goes below 4 p.p.m. or 3 p.pm., and in some streams that might be indefinite if there is a little dilution, and, again, that might be only a matter of some hours, fish could exist. I have had fish living in the effluent, for experiment purposes, right at the test plant. But if the flow is 16 to 24 hours older, the fish might die if the oxygen is exhausted.

2587 My earlier testimony before Mr. Hughes was with relation to overall treatment, which was set at 85 per cent as an annual average. I further testified that on our activated sludge treatment at the plant, we expected to attain 90 per cent or better for a number
2588 of months and maybe for averages. I believe that around 1925 to 1928 a 90 per cent purification was considered a very good effluent for our class of sewage. Trickling filters ran around 85 per cent. In 1928 the Sanitary District had only operated a small plant, treating 4 m.g.d., known as the Des Plaines River Works. Since 1928, we have operated the North Side and the Calumet, and conducted experimental work

in addition. Therefore, my opinion is entitled now to be weighed on what I know today in trying to solve these problems and not what I said 15 years ago.

I testified before Mr. Hughes in 1929. The hearings
2589 ran from March 25 through September 25. The North Side Works started in October of 1928, and was operated at about on-third of its nominal capacity. In January and February, there was excess capity. The aeration period was 7.2 hours, instead of the bases we have learned is useful, that is, 5 hours. We may have attained those percentages, but we were not sure we could sustain them indefinitely. Two or three months at the beginning of operation at the North Side Works has small influence on what I learned in the last 12 years. I have admitted that if there is the time period and more air, a better effluent can be produced. The Sanitary District is trying to expend the public money to best advantage in a rather difficult situation on its operating finance.

In the 1928 pamphlet issued at the opening of the North Side Works, there may be been a statement that the effluent would be clear, sparkling, and resemble drinking water. I did not sign it. It was written by a newspaper reporter. I recall telling him he had better strike out that kind of stuff. I am not responsible for whatever is printed by the District.
2590 If the potency of the effluent of an activated
2591 sludge plant working at 90 per cent efficiency is measured by the B.O.D. test, it would be approximately the same as the potency of one-tenth the volume of raw sewage. If you are trying to measure the

potentialities of the case, raw sewage contains sludge producing elements which are not in the effluent.

2591 Assuming 85 per cent treatment on a population of four million leaves a balance of 600,000 people. The effluent of this treatment may not exert the same influence on the Main Channel as the raw sewage
2592 of 600,000 people. The raw sewage would deposit sludge down the Channel, which later decomposes and exerts B.O.D. The discharge of raw sewage carries different implications under our situation than if effluent were discharged. The raw sewage has more potentiality for trouble. Under certain conditions, sludge deposits in the Upper Illinois River
2593 might exert an oxygen demand in the summer as great as the original B.O.D. of the incoming sewage. Another factor in our situation is the storm flow effect. When I speak of taking all the sludge out, I mean that I expect to take out all the readily settling solids removed by a treatment plant. The residual solids are very much less harmful than the original sewage solids.

2594 In North America in only two cases has storm water been treated, Columbus, Ohio, and North Toronto in Canada. It is expensive.

Ramey testified that precipitation occurs about 110 times in an average year. There may be 55 storms which tend to fill the interceptor, and at least 5 to 7 which make a heavy discharge through the sewer outlets. Thus varying amounts of raw solids enter the stream without treatment. If the storm water is ten times the dry flow, and only 1-1/2 times the

dry flow is treated, 85 per cent of the solids enter the stream during the storm.

2595 No sanitary engineer would say that all the sludge producing material is removed from the channels of the District, when its sewage has been treated. There is still some remaining material entering the Waterway. Sometimes in a storm the B.O.D. rises at Lockport. The effect of storm water will need to be watched, after the treatment works are built to treat all the liquid and retain all the solids possible in the plants.

Cross-Examination by Mr. Cohan.

2596 If a treatment plant is working at 85 per cent efficiency, on 4 million people, ordinarily the answer would be that 15 per cent of the organic matter is in the effluent.

2597 Plant efficiency is commonly measured by the B.O.D. test or the suspended matter test. No one has tried to develop a test to reflect the potentialities I have discussed.

Examination by the Master.

2598 Assuming a city of 600,000 people discharging untreated sewage into a canal, and another situation with a city of 4 million, discharging sewage treated 85 per cent, and that both places have the same flow in gallons per capita, the ratio of volume is 400 to 60.

Assuming for convenience the people are 400,000 and 4 million, the volume of the flow from the latter

is 10 times that from the smaller city. If B.O.D. tests were made, the raw sewage might be assumed as 100 and the 85 per cent treated effluent as 15.

The third step is what happens because of the material carried in the liquid. The volume contains sol-
2600 ids in suspension and solution. If the original sewage contains 200 parts per million of suspended solids, and if the effluent only contains 10 parts per million, the raw sewage in every unit of volume contains 20 times as much suspended matter as the effluent. The suspended matter may deposit, and make a potential condition, which means the effect of that sewage pollution is far greater in the summer months than in the winter. We do not try to express this, because as as matter of routine we are interested in knowing what the plant does. In studying the conditions of the Canal and River, all factors are considered.

2601 If a man is sick, the doctor analyzes all causes, not merely whether the man has a bag leg or a good leg.

In this case, we have applied a simple test and discussed the efficiency shown thereby. I see no way to extend the method to a broader situation.

I would rather live on the banks of a stream receiving the 85 per cent treated sewage of a town of 4 million people than on the banks of the same stream at the same location into which emptied the raw sewage of a town of 600,000 people. In the case of the 4 million people, the stream would be relatively clear and unpolluted to the eye, without odors. In the other case there would be a dark looking stream,

which would give off odors and obviously would consist of untreated sewage.

Cross-Examination by Mr. Naujoks.

2605-
2606 The Kostner Avenue sewer, with a flow of about 45 m.g.d., should be connected up shortly.

Dr. Mohlman's curve and chart can be adjusted, after an appraisal of population and industry and plant operation.

Cross Examination by Mr. Naujoks.

2730 The Southwest Plant is limited in its flow to 600 m.g.d. by pump capacity and air lifts. At 600 m.g.d. the period in the aeration tanks is approximately 3.15 hours. With three blowers now installed running, and a flow of 600 m.g.d., the air supply figures 0.35 cubic feet per gallon of sewage for service to the aeration tanks. However, only two blowers can be relied upon for continuous service. With two, the air supply fig-
2731 ures 0.21 cubic feet per gallon. To attain an aeration period of 1.45 hours is purely hypothetical and impossible as it means pushing through an entering flow of nearly 1200 m.g.d. in a plant actually limited to 600 m.g.d. but with a theoretical hydraulic capacity of 750 m.g.d.

Air in amount of 120,000 cubic feet per minute is not available at the Southwest Works from two existing blowers for aerating mixed liquor. The air for auxiliary uses totals 21,000 cubic feet per minute at

present which may increase to 24,000 cubic feet per minute as the output of dried solid increases. The net air available is 98,800 cubic feet per minute. Arithmetically this provides for 800 million gallons air at the rate of 0.1778 cubic feet per gallon. With three
2732 blowers running, as a matter of arithmetic, the air available for aerating 800 m.g.d. would be 0.286 cubic feet per gallon. The average for 5 months, April to August, inclusive, in 1940 shows preliminary treatment given to 163 m.g.d. at the Southwest Works. The raw sewage contained 202 p.p.m. Suspended solids and 151 p.p.m. B.O.D. The tanks made a reduction in B.O.D. of 33 per cent. The B.O.D. of the treated sewage was 101 p.p.m. The population equivalent is 807,000 persons on the bases of 0.17 pound per capita. The population equivalent for the 53,970 tons of dry solids discharged to the canal in 1939 is being worked out. Assuming the net dissolved oxygen in Lake Michigan water to be 8 p.p.m. the content of dissolved oxygen in 3500 c.f.s. of lake water would be 151,200 pounds per day. The dissolved oxygen in the lake may be between 8.5 and 9.5 p.p.m., from which an allowance for B.O.D. is deducted, leaving a reasonable net of 8 p.p.m. The amount of 151,200 pounds per day of oxygen would satisfy the 5-day B.O.D. of 889,410 people on the assumption of 0.17 pounds of 5-day B.O.D. per capita.

2734 I have prepared an exhibit, Pearse Cross. Exam. Exh. 4, which shows the interchange of sewage from the West Side interceptor to the Southwest intercep-
2735 tor or vice versa. This shows that from May, 1939, to March, 1940, a considerable amount of sewage from

the West Side was diverted to the Southwest. In 1940 in June and August some flow went from the West Side to the Southwest. In August 5 m.g.d. was so diverted.

2736 The reductions in diversion from the West Side system synchronize with the pickup of additional City sewage by the Southwest system.

2737 The Southwest plant began operation on West Side sewage. Not until April, 1940, were both plants on their own. The West Side plant ran far below its capacity from September 1939 to February 1940.

2738 The sewage coming to the Southwest plant had previously discharged untreated through the West 39th Street Conduit, which is now connected to the Racine Avenue Pumping Station; the Western Avenue sewer and other sewers entering the South Branch of the Chicago River.

2739 The Kostner Avenue sewer was connected up on September 26, 1940. This reduces the sewage not connected by about one-half. About 55,000 population is
2740 left untreated. This means the Sanitary District has approximately attained the stage of pick-up of sew-
2741 age, indicated by the petition of the State of Illinois. (Petition p. 11). The area from which untreated sewage flows comprises the Clearing District, certain areas around Blue Island, a small sewer in the Stockyards, and miscellaneous small situations. These have not been picked up because of the expense involved. The extension of the Summit-Argo sewer to Clearing is delayed because of adjustments in the Corn Products plant. The method of handling its residual pollution

is being worked out. These smaller projects make excellent WPA projects.

Cross Examination by Mr. Cohan.

2752 There is no assurance from the City when it can meter the water. At the average rate of installing meters in the last ten years it will take 100 years. Opinions differ as to how low the flow can be reduced by metering.

2753 The works of the Sanitary District are designed to a capacity ample for present conditions. The City has no appropriation on its books for the purchase of 2754 meters. The money allotted to meters in the PWA fund for the filter plant construction has been spent for other purposes. In general meters are purchased at the expense of the consumer.

2755 The Sanitary District has not predicated its plans for construction in the next two years on the metering of the Chicago water.

In the light of past performance any prediction based on metering is purely speculative. The District investigated the situation, gave it proper consideration and concluded it did not influence our problem.

Quoting Mr. Andrew

Examination by the Master.

2757 In connection with a proposed test to flush the Brandon Pool, I have serious doubt whether the flocculant material will flow out. If it does, the gates

should be opened at Dresden Island Pool, Marseilles Dam, and Starved Rock Dam to allow the material to work on down the waterway. This will require investigation.

At Dresden Island Pool an electric generating station draws water from the Pool. At Marseilles there is a hydro-electric plant.

To drain even one pool is serious, to say nothing of draining several pools.

2759 In my opinion the Chief of Engineers would not feel it was feasible to permit opening the gates at all these pools to permit draining out the flocculent material, if it can flow out.

LANGDON PEARSE

Direct Examination by Mr. Clausen.

3313- I have prepared population data on the counties
3316 and towns on the Illinois River from data from U. S. Census Bureau.

3318 Data on the population of Joliet prisons was obtained from the Department of Public Welfare of the State of Illinois.

3320- I have prepared data on the population in The
3321 Sanitary District of Chicago for 1940 and its distribution, from press information, as census figures
3321 not available. The increase in human population from 1930 to 1940 in the Sanitary District is esti-
3322- mated at 65,031, and the increase in industrial equiva-
3324 lent population is estimated at 596,180 from 1930 to 1940. Including Argo, the combined figures show:

Population	Estimate for 1930	1940
Human	*3,901,569	**3,966,600
Industrial Equivalent	1,486,000	2,082,180
Total	5,387,569	6,048,780

* Census
** Estimated

3326 Assuming chemical treatment applied to the West Side effluent, reducing B.O.D. from 57 to 37 and being equal to the population of 440,000; and adding treatment as of May, 1940 (from January, 1940 Illinois Petition) including one-third West Side sewage diverted to the Southwest plant; I find the reduction in B.O.D. in May flow was equivalent to 286,000 population, and treatment per cent increased from 75.1 to 81.4.

3328 I find in the period April to August, 1940, that if the 163 m.g.d. of sewage given only preliminary settling at the Southwest Works had received activated sludge treatment, the effect would be equivalent to a removal of 719,110 population with sludge kept on shore, or 479,220 population if excess activated sludge went to the Main Channel.

3331 There are several methods of comparison of conditions in a waterway before and after treatment is installed; first, compare volume of treated sewage and raw sewage; second, compare weights of suspended solids discharged into the stream, either on total or
3332 volatile solid basis; third, compare the concentration of the B.O.D. and dissolved oxygen at various points along the Waterway; fourth, a study of the oxygen

balance. I do not think Howson Exhibits 13 and 14 are a true oxygen balance. They merely represent sources of material.

3335 In comparing conditions in the Main Channel and Chicago River, of June, 1937-1938 with 1939-1940, following the cut in diversion, the concentration of B.O.D.
3336 increased and the dissolved oxygen decreased. The effluent of the North Side Works lost all its dissolved oxygen in passing down the North Branch to Chicago Avenue, due to sludge deposits, industrial wastes, and
3337 possible ineffective dissolved oxygen in effluent of wastes. Comparing the average of June, July, and August, 1938-1939 with 1939-1940, following the cut in diversion, the concentration of B.O.D. increased and the dissolved oxygen decreased.

3341 The estimate of the B.O.D. and the dissolved oxygen in the Upper Illinois Waterway for June, 1938 to 1943 left open for figures on effect of sludge deposits a very important element. Reareation effect is
3342 also omitted. It is necessary to remove the sludge forming solids entering the stream as promptly as possible.

Pearse Cross-Examination

3343 Exhibit 12 differs from Howson Exhibit 11 in that it assumes the Southwest plant and additional West Side will not be complete until the end of 1942. Many
3344 figures are the same as used by Howson in Exhibit
3345 11. Others differ. Howson overlooked the B.O.D. from a large amount of raw sewage which entered the stream in 1939.

3348 The estimate of the B.O.D. and the dissolved oxygen in the Upper Illinois Waterway for June, July, and August, 1938 to 1943, as shown in Pearse Cross Exam. Exh. 13, is a companion piece to Howson Exh. 14. Left open for figures on the effect of sludge deposits, a very important element. Sludge deposit effect may exert demand of 510,000 B.O.D. daily in June, 1938.

3349 Sludge may exert a demand almost as much as
3350 the demand of the sewage itself. Sludge demands are estimated from a correct oxygen balance, trying to determine two unknowns; one, the amount of the oxygen demand of the sludge, and the other, the amount
3351 of reaeration at the surface. The different factors
3352 must be studied from their proper time relation. In the summer, there is a double demand on the stream. Confirmed by the Eddy report of the Engineering Board
3355 of Review. The sludge demand is indicated as of the time in question; for 1940 as of today.

3357 I find in Howson Exhibit 12 a neglect of the importance of the aeration period, when proposing more
3358 air. It is difficult to finance such proposals. Time for building chemical precipitation to supplement West Side Works is as long as for activated sludge plant. Installation for chlorinating the Canal water
3359 has no space. I believe aeration by cascades at Lockport is of little value in effect on Brandon Road Pool. Not much use in removing compacted solids unless
3360 to remove an obstruction to navigation. Addition of settling basins for temporarily speeding up flow to
3363 Southwest Works will cost more than Howson estimates. The cost of the gate house, conduits, and meters

should be $1,300,000 instead of $610,000. Roads and grounds should also be included, in amount of $90,-600. This increases the Howson total of $3,267,000 to
3364 $4,048,000. This estimate includes $600,000 for temporary conduits, which are of no value in the permanent scheme. The total is close to the Sanitary District estimate of $4,878,500 for the entire activated sludge extension.

3364 I believe it is preferable to push ahead on the complete program. Plans on 16 final tanks for Batteries
3365 A and B are under way and work should be under contract in March, 1941, and completed between June and December, 1942. Presents tanks need modification
3366 for betterment. Plans for Battery should be started this winter; work under contract by September, 1941, and completed by December, 1942.

3367 The Sanitary District of Chicago is a municipal corporation, organized and existing under the laws of the State of Illinois. It is operated by a Board of
3368 Trustees. It must advertise for at least ten days, usually two or three weeks on large jobs. Bids are referred to the Chief Engineer, canvassed, and reported to the Board. If the low bidder is financially responsible, contract is awarded. At a subsequent meeting, the bond is approved and the Chairman of the Finance Committee and the Clerk authorized to execute the contract.

3368 The Howson scheme for treating 800 m.g.d. in the Southwest Works is impracticable, for several reasons; first, the top hydraulic capacity of Batteries A and B is 750 m.g.d.; secondly, the peak loads during six to ten hours of the day would run the excess over

3369 750 m.g.d. to as high as 200 m.g.d.; thirdly, the air
3370 supply is limited, and the probable limitation until next August would be around 500 to 550 m.g.d. to have enough air for a fair effluent; fourthly, the amount of activated sludge solids would be increased to a point where the equipment is inadequate, until the entire
3371 Southwest plant is available. The plans for the 16 final tanks for Batteries A and B are being pushed. Little value in shoving the 24 additional tanks ahead without the aeration tanks of Batter C and the sludge handling equipment.

3372 I find with reference to Howson Exhibit 13 that in the principal sources of B.O.D. some errors are ap-
3373 parent. The largest error is in line C, where in the 1939 column there should be 427,000 pounds instead of 266,000. This is due to the omission by Howson of certain raw sewage from the Southwest area. These
3375 corrections increase the total of 496,000 by about 160,-000. The summation as presented by Howson is incorrect for 1939. Should be about 657,000 pounds. As present, Exhibit 13 is erroneous and misleading, because of the omission under 1939 of the raw sewage factor, as noted.

3374- I find with reference to Howson Exh. 14 that com-
3375 ments similar to those re Exh. 13 hold.

3378 The construction of cantonments by the United States Government is not an index of construction for large sewage treatment works. In the last war, I was connected with the work at Camp Custer. Can-
3379 tonment construction is entirely different from the sewage treatment works of the Sanitary District. The Government approaches the problem with unlimited

funds and power, both to comandeer men and materials. Cantonment work is repetitive and spread over a wide area, with a minimum of plans and a
3380 maximum rapidity of construction. Cantonment work is construction of a temporary nature.
3383 The financial status of the Sanitary District is such that we are operating under a pegged levy to produce
3384 $5,000,000 annually. The Engineering Department has no money to expend on additional air or the purchasing
3385 of chlorine or chemicals. The operating budget could be thrown out of balance by any order to spend on such ameliorating measures.

Direct Examination by Mr. Clausen.

3633 I have prepared certain exhibits bringing the operating records down to date. Illinois Exh. 24-A shows
3636 in 1940 a yearly average of 422.7 tons per day of dry solids removed from sewage at the sewage treatment
3638 works; Illinois Exh. 25-A shows that in 1940 the av-
3642 erage flow was 929.9 m.g.d. at the sewage treatment works; Illinois Exh. 27-A shows at the North Side Works a yearly percentage removal of B.O.D. of 94.6 in 1940, the highest since 1929; Illinois Exh. 28-A shows
3644 at the Calumet Works a yearly percentage removal of B.O.D. of 90.7 in 1940, the highest in its history;
3645 Illinois Exh. 29-A shows at the West Side Works a percentage removal of B.O.D. of 50.0 in 1940, with the
3654 largest flow in its history, 361.5 m.g.d.; Illinois Exh. 47-A shows the Southwest Works gradually picking
3656 up its sewage load. Illinois Exh. 49-A shows in 1940,

on an estimated total sewage flow of 1053 m.g.d., that
3658- 930 m.g.d. was treated and 123 m.g.d. untreated. Il-
3660 linois Exh. 50-A and 51-A show that in 1940 the total tonnage of dry sludge and grit at the sewage works
3662- was 151,933. Of this, 20,224 reached the Main Chan-
3664 nel. Illinois Exh. 52-A and 53-A show that in October, November, and December of 1940 no sludge was
3662 discharged to the channels of the Sanitary District. Illinois Exh. 52-A shows that in October, November and December of 1940, 6,382, 6,587, and 6,759 tons of sludge were heat-dried, respectively, at the Southwest Works, the highest averages since operation began.
3670 Pearse Cross Exh. 4-A shows that since March, 1940, from 10 to 70 m.g.d. of the West Side sewage has been treated at the Southwest Works.

3672 Exhibit 40-A "Main Channel Discharge at Lockport—1938, 1939, and 1940" offered by Pearse and received.

3673 Exhibit 62, "Diversion from Lake Michigan, showing Monthly Discharges for 1938, 1939, and 1940" offered by Pearse and received.

3679 I collaborated with Dr. Mohlman in the preparation of the Mohlman Report on the flushing experi-
3680 ment and subscribe to the Summary and Conclusions therein. I believe the summer of 1941 may present better conditions in Brandon Pool than in 1939.

3682 The Southwest Works is operated to produce sufficient sludge, plus the North Side sludge, to supply dewatering apparatus. The eight dryers are not yet operating, but are in process of erection, due to delay in obtaining rubber covered pipe, on account of interfer-
3683- ence of National Defense. New crushers are expected

to be in operation by May. Additional blower is expected to be in operation by August.

In the present operation, the preliminary sludge is put in the West Side tanks; surplus sludge to temporary lagoons. A small lagoon was completed in the fall of 1940 and an additional lagoon is nearly finished. No excess sludge is to be placed in the channels. Lagoons now on hand may not be adequate for the entire year of 1941. Can be enlarged if necessary. The lagoons are an emergency measure.

I cannot state from Illinois Exh. 60 and 61 just what will happen in 1941, 1942, and 1943. I made Illinois Exh. 60 and 61 on the Howson pattern, but correcting his figures where need be. The Howson exhibit is not an oxygen balance. The statement of figures in Lockport in 1938, 1939, and 1940 are actually what occurred.

Examination by the Master.

At the Southwest Works, the eight additional filters will not be ready until March 1, 1941. New coal crushers will not be ready until May 1, 1941. The blower should be ready by August 1, 1941. A temporary lagoon has been constructed. At the present time the existing equipment is handling 200 to 210 tons of dry activated solids in dewatering and drying, and we expect by June to handle 250 to 260 tons of dry solids per day, for sale as fertilizer or for burning. The operating program for 1941 and 1942 is based on giving activated sludge treatment to sufficient sewage

to produce enough Sludge to combine with the North Side sludge and stay within the dewatering and heat-
3935 drying capacity. All the sewage receives preliminary settling. The sludge from the preliminary settling is sent to the West Side Works; digested, and the excess placed in the temporary lagoons. The period of preliminary settling as around 11 to 13 minutes instead of 20 to 30 minutes, earlier stated. Performance of Southwest Works for next two years measured by amount of sewage receiving preliminary treatment
3936 only. No sludge as such has been discharged into the Waterway during the last three months of 1940.
3937 Weighted average of Southwest plant was lower in November and December, 1940 than in the summer for removal of B.O.D. and suspended solids.

3938 The performance of the Sanitary District plant for 1940 and for the year was removal in per cent, B.O.D. 67.8, suspended solids, 72.5. For April to Demember, the removal in per cent was—B.O.D. 65 per cent, and
3839 suspended solids, 71 per cent. The performance of the plants is obstructed by the choke in the Southwest Works, which is inability to dispose of solids plus relation of disposal of preliminary solids to the West Side Works and sludge drying beds, which are not adequate to take all preliminary sludge. Temporary
3940 lagoon ought to carry through 1941. The B.O.D. discharged in Southwest effluent for 1941-1942, as shown in Illinois Exh. 60 and 61, was too low—error in computations.

3941- On the question of lagooning, we have found la-
3942 gooning of activated sludge proved unsatisfactory unless mixed with digested sludge. If the extent of

the difficulty caused at Joliet by the lack of equipment due to lack of money had been more adequately foreseen, some temporary steps might have been taken to provide more adequate lagoons.

Cross-Examination by Mr. Naujoks.

4033- In accordance with the request of the Master, I
4034 have checked Illinois Exh. 60 and 61 and produce herewith the revised compilation of figures, Illinois Exh. 60-A and 61-A.

4034 Little difference is expected in sewage works operation between 1941 and 1940, while a greater difference may occur between 1941 and 1942 than shown
4035 on the Exhibits. The extent of the difference will depend on the additional treatment gained by the new blower due by August 1, 1941. This may lower the B.O.D. at Lockport, but the D.O. will still be zero.

4038- The condition of the Brandon Pool in the summer
4039 of 1941 will be worse than the condition at Lockport.

4049 Credit was given for reaeration in Illinois Exhibits
4050- 60, 60-A, 61, and 61-A. Adjustments were made up-
4051 ward on Illinois Exh. 60-A and 61-A, because operating figures on the Southwest Works were too optimistic for 1941 and 1942. In 1943 and 1944, as shown on
4052 Illinois Exh. 60-A and 61-A, our figures are somewhat more optimistic than on Howson Exhibits.

4052- Estimates on the effect of sludge deposits based
4053 on experience of last fifteen years and including work of Engineering Board of Review. Differences between

4053- our figures and Opponents' on what will occur
4054 largely due to Howson assumption plants are completed in 1941 and Illinois assumption plants cannot
4056 be completed until end of 1942. Differences caused
4057 by change in judgment. Change of judgment caused by slowing up of construction program and effect on operation of attempt to keep all sludge out of the Main Channel. Earlier estimates too optimsitic.

Examination by the Master.

4058 Effect of sludge deposits is reduced in 1941 and
4059 1942. Effect of sludge deposits should decline as sol-
4060- ids deposited decline. Relationship of sludge depos-
4061 its to sludge discharge. No sludge now discharged. Volume of untreated sewage has declined. Figure for
4062 untreated sewage adjusted between Illinois Exh. 60, 61, 60-A, and 61-A.

4063 Sludge deposits refer to the oxygen demand of material deposited in the channels. Effect comes from past and current deposits. Separate items from North Side, Calumet, and Southwest sludge are for sludge discharged from the plants. Such items are not re-
4064 flected under effluent items of B.O.D. Storage of material through the winter months is a factor. The B.O.D. of a sludge deposit is in addition to the B.O.D.
4065 of the sewage then coming. Effect of current deposits of sludge declines also.

Cross-Examination by Mr. Naujoks.

4065 Gave no credit to effect of removals of solids dur-
4066 ing test of December, 1940. Test may have stirred up material and uncovered fresh surfaces. Considered effect of test on the system, but did not include any
4067- figure for such effect. Arithmetic compuation vs.
4068 appraisal as to effect of solids removed during test period. Sketch of general method employed for oxy-
4071 gen balance determination. No definite figure available first, on effect of sweeping out, or, secondly, on effect of what is left in, or on effect of current material coming. Knowing conditions and appraising effect at somewhat less than one-half the value of the
4072 sludge deposits in 1940 seems fair. Gave credit for reaeration in transit.

4074 *Memo. on Lagooning,* Pearse Exh. 15-A and 15-B.
4075 Existing lagoons (area 37 acres) on West Side site have a volume capacity of 250,000 cubic yards, or 16,800 tons of dry solids in sludge at 92 per cent moisture. 27 acres of lagoons, 5 feet deep, cost $38,000.
4076 Additional area available of 20 acres would hold at 5 foot depth 145,000 cubic yards, or 10,200 tons of dry solids at 92 per cent moisture. Lagoons on West-Southwest site will hold 27,000 tons of solids.

At the Southwest Works, handling about 350 m.g.d., preliminary settling period is 15 minutes. Only sufficient settled sewage is given activated sludge treatment to produce solids up to the capacity of the sludge handling plant. In December, 1940, Southwest Works handled 210 tons dry solids per day, including 100 tons from the North Side. If the 13-minute settling period continues in the preliminary tanks, the 27,000 ton

4077 lagoon will suffice until 1943. If the settling period be increased to 40 minutes, at the Southwest, the total capacity of 27,000 tons of dry solids at 92 per cent moisture will be exceeded in the winter of 1941-1942. Additional area for lagoons is available four miles to the southwest of the West Side Works. The lagoons, to hold 31,000 tons of dry solids at 92 per cent moisture, would require 31 acres. The cost of a sludge pipeline, pumping station, lagoons, and fencing would be about $165,000. On the 40-minute settling basis, about 15 acres of lagoons, 10 feet deep, are required per year for the excess digested sludge from the preliminary tanks at the Southwest Works.

4078 The rate of drying in lagoons on the additional area site is very problematical, due to the type of soil. At Indianapolis, on a sandy soil, the period of rotation is about six years.

Explanation requested by the Master.

4199 Weighted average, as in Pearse Exh. 16, is obtained by multiplying the B.O.D. of the various effluents by the respective gallonage and the sum is divided by the total gallonage.

4200 Settled sewage (Rec. 4076) refers to the effluent of the preliminary settling tanks.

4499 Complete treatment during December, 1940 at the Southwest Plant lower than in October and November, probably due, first, to increased total solids as strength of sewage increased, and, secondly, to the handling only of sufficient sludge for shipments on order because of condition of equipment.

FLOYD W. MOHLMAN, Director of Laboratories,

The Sanitary District of Chicago.

Direct Examination.

234 I reside at 10724 Drew St., Chicago, Ill. I graduated at the University of Illinois in chemistry in 1912, and received a Master's Degree in 1914 and a Doctor's Degree in 1916 in sanitary chemistry, with a minor in bacteriology and a second minor in sanitary engineering. In 1916 I was instructor in sanitary chemistry at the University of Illinois, and chemist and bacteriologist of the Illinois State Water Survey. In 1916 I went to New Haven, Connecticut, to take charge of investigations of sewage disposal for the City of New Haven. Later I worked for the State of Connecticut, in charge of investigations of stream pollution and industrial wastes. I came to Chicago in 1919 as Chief Chemist for The Sanitary District of Chicago and have been here ever since. My title was later changed to Director of Laboratories.

For the past twelve years I have been editor of the
235 Sewage Works Journal, a national publication on sewage research and sewage plant operation. For several years I have been a lecturer on sanitary chemistry, stream pollution, and the disposal of industrial wastes in the Graduate School of the Armour Institute of Technology.

In the Sanitary District I am in charge of all of the laboratories and the work of such laboratories in chemistry and bacteriology. In 1925 I organized the chemical investigations of the Illinois River, that

have continued to date. In the laboratories here in the city we take care of all chemical work that is done
236 to measure the efficiency of treatment by the sewage treatment works. In addition, our laboratory work has included a survey for the past five years of the wastes from some 250 industrial establishments in the city. I have also been in charge of the chemical work connected with the investigations of new or improved processes of sewage treatment, both in the laboratory and in experimental stations.

There are four laboratories in the city and three down the Illinois River under my direction. We have
237 about seventeen chemists and numerous samplers. Approximately 9,000 samples per month are analyzed for dissolved oxygen content in our laboratories.

Samples have been collected and analyzed continuously on the Illinois River since 1925, and at Lockport, one of the most critical stations on the river, we have made thorough investigations ever since I came here in 1919. On streams within the City of Chicago we have continuous records of analyses since 1935.

238 The purpose of the analyses is to furnish a quantitative measure of river conditions as affected by treatment of sewage and reduction of diversion; the most important results are those obtained since 1938. The critical stations are in Chicago and down to Lockport and below; entrance of the Kankakee River greatly improves conditions.

239 The dissolved oxygen test shows the condition of the water; Lake Michigan water is practically saturated with dissolved oxygen, varying from 14 parts

per million in winter down to 8 or 9 p.p.m. in summer; such water has a very low demand for oxygen, and brings in assets of dissolved oxygen. Additional oxygen is gained from absorption at the surface; from aeration over dams; and a certain amount is present in sewage effluents, although a rather low amount.

240 On the other hand, the biochemical oxygen demand expresses the avidity for dissolved oxygen of the putrefiable matter in sewage or effluents. The B.O.D. may be considered as a liability to be balanced against the assets of dissolved oxygen. If the B.O.D. exceeds the available dissolved oxygen, anaerobic conditions result, and odors occur and the foul conditions noted in the Drainage Canal and Illinois River. The dissolved oxygen decreases down to zero, then the B.O.D. shows the amount of polluting matter.

241 Sewage treatment reduces B.O.D. to varying degrees and thus improves the oxygen balance. In addition to the drain on the oxygen by sewage and effluents the sludge deposits on the bottom of the stream induce a very serious oxygen demand. Imhoff or activated sludge treatment reduce the oxygen demand and remove solids so as to result in a positive oxygen balance, with dissolved oxygen present, and no odors or nuisance.

242 In following the course of dissolved oxygen and B.O.D., I will show on Illinois Ex. 5 how the samples are collected at the mouth of the Chicago River, where the water is taken for dilution purposes. Other samples are taken down the South Branch, and at Summit, which is below practically all of the sewage

treatment works. Samples are also collected above the dam at Lockport.

243 These samples are analyzed for dissolved oxygen and B.O.D. I can demonstrate the test for dissolved oxygen on some samples collected this morning at the mouth of the River, the pure lake water, then at Halsted St., about three miles down the South Branch, and another at Summit, fourteen miles from the Lake.

The tests I will make are merely for demonstration purposes, and I don't consider that the results will
244 show the average conditions, but only for the samples as collected between eleven and twelve o'clock this morning. The test is a standard test, in which chemi-
245 cals must be added to the samples. The oxygen is fixed in a precipitate, in which you can gauge roughly the oxygen content ~~by~~ the darkness of the sample. Then sulfuric acid is added, and at this stage the oxygen is fixed as iodine, and the more oxygen that is present, the more iodine you will find. Thus sample one, from the lake, is darkest, number two from Halsted St. is
246 lighter, and number three, from Summit, is white. The next procedure is to titrate a measured quantity of the iodine solution against a solution of sodium thiosulfate, which is what I am doing. Before the yellow color disappears, I add a few drops of another reagent, starch, which changes the color to a deep blue. Finally a last drop of sodium thiosulfate causes the blue color to disappear. The dissolved oxygen in that sample was 9.6 parts per million.

The second sample, from Halsted St., is treated the
247 same way, and is found to contain 6.7 p.p.m. The dis-

solved oxygen is lower than at the Lake, due to the oxygen demand of bottom deposits and the effluent from the North Side Plant.

The third sample, from Summit, contains zero dissolved oxygen. From there down, through Lockport and Brandon's Road, oxygen is completely gone from the water.

Summit is below all the treatment works. The
248 sample from Summit has an odor and a turbid appearance.

The B.O.D. determination shows how much dissolved oxygen is used up when a sample of water is incubated for five days at 20 deg. Centigrade. It thus measures the avidity of the water for oxygen.

249 These tests have been carried on in the same way and at the same places prior to and after the reduction of diversion from 5,000 to 1,500 c.f.s. I have prepared six exhibits of monthly average results at six
250 stations on the river. These are offered as Ill. Ex.
to 31 to 36, inclusive, covering the period from Jan.,
262 1938, through June, 1940.

263 The results of analyses of samples from the mouth of the river extend back only to November, 1939, because I am familiar with what the dissolved oxygen should run in Lake Michigan, but I started then to show what a normal year might show. Exhibit 31 shows 14 parts per million in Jan., 1940, and 10 p.p.m. in June. The oxygen demand is small, extending from 1 1/2 to 3 p.p.m.

264 The temperature, in Centigrade, is 16 degrees in June, equivalent to 61 deg. F. In summer the dissolved oxygen will be lower, possibly 8 1/2 to 9 p.p.m. That

is the water we have to draw upon for our assets of dissolved oxygen.

Exhibit 32 shows results at Damen Avenue, below the stockyards. The B.O.D. has increased over the dissolved oxygen, but in 1938 there was always dissolved oxygen present, with a minimum of 5 p.p.m. in July.

265 In 1939, however, when the diversion was cut, there was a sharply increased B.O.D. in January and it increased enormously to 55 p.p.m. in May. In June it dropped to 20 p.p.m. and there was a fluctuating increase and decrease to the fall of the year. The dissolved oxygen was very low in April, 1939, and in August and September, 1939, it was completely gone.

In 1940 the B.O.D. is still very considerably above the year 1938. The high month of March, 1940, with 21 p.p.m., compares with a very low result, not over 13.5 p.p.m. all through the year 1938. Therefore the B.O.D. in 1939 was far greater than at any time in
266 1938, and it was still well above 1938 in 1940. The month of June, 1940, shows a low B.O.D. as the stockyards wastes have been intercepted and taken out to the Southwest Plant for treatment.

Exhibit 33 shows results at Summit. The dissolved oxygen results are lower than at Damen Avenue. In 1939 there were six months with no dissolved oxygen at all at Summit. In 1940, there was an increase to 4 p.p.m. in the winter, but in June, the B.O.D. showed a tremendous increase up to 44 p.p.m. and all of the year 1940 is far worse than anything in 1938.

267 Exhibit 34 shows results at Lockport, including discharge, which is the diversion plus the city pumpage.

In 1938 the dissolved oxygen was low during the summer months, but in January, 1939, it was almost completely depleted, whereas there was 7 p.p.m. in January, 1938. The B.O.D. reached a maximum of 43 p.p.m. in 1939, and from 23 to 27 p.p.m. in 1940 (compared with a maximum of 22.6 p.p.m. in 1938).

Exhibits 32, 33 and 34 show the conditions in the Main Channel were far worse in 1939 than in 1938, and in 1940 they were still worse (than in 1938).

268 Exhibit 35 shows results at Marseilles, down below the Kankakee River. Here the river is recovering its aerobic condition, with a substantial amount of dissolved oxygen from 1938 to date. The minimum of 2.4 p.p.m. in June, 1939, is however, very low in comparison with the dissolved oxygen content of Lake water.

Exhibit 36 shows results at Chillicothe, 147 miles from Lake Michigan. There is always a substantial amount of dissolved oxygen at Chillicothe, but the 269 B.O.D. showed some rather high values in 1939 and again in 1940. They indicate that conditions were not so good as in '38, even that far downstream.

The general effect of treatment is to cause conditions to become better downstream and then to work upstream as conditions improve. Chillicothe indicates about the lower point of our interest in the investigations of the Illinois River.

270 These charts have two main purposes; first, to show the concept of balance between dissolved oxygen and B.O.D. and the recovery of the stream; and second, to show the increase pollution in 1939 and 1940, as com-

pared with 1938. They indicate 1940 was somewhat better than '39 and worse than '38.

These charts show a quantitative measure of pollution, and the efficiency of dilution or other dissolved oxygen assets to equal that pollution.

The station at Lockport is above the powerhouse, in the drainage canal.

271 Exhibit 37 shows the results over a long time at Lockport, from the start of investigations in 1925. These monthly average results show that from 1925 through 1938 there was a certain amount of variation in the 5-day B.O.D., as one would expect, but at no time was there a sharp and notable increase. The di-
272 version was cut from 8,500 to 6,500 cu. ft. per second in 1930, at the time of the Decree. On Jan. 1, 1936, it was cut to 5,000 c.f.s., and held there for 1936, '37, and '38. On Jan. 1, 1939, it was cut to 1,500 c.f.s. There was a tremendous increase in B.O.D. at that time, and from then until May, 1939, there was a very notable increase, more than doubling anything that had ever been found since this investigation started. Up to June, 1940, the results are still well above anything in the years up through 1938. In every summer through 1938 the dissolved oxygen has gone down nearly to zero for three or four months, but starting in January, 1939, there was a very decided drop instead of
273 an increase that occurred every year prior thereto, and in the summer of 1939 there were seven months with a complete absence of oxygen, no increase in the winter (1939-40) and practically zero through the summer of 1940 to date.

The temperatures (of the water) in the summer of 1939 showed an increase to anything we had before.

The great increase of B.O.D. in 1939 is significant, particularly in the summer. A much heavier pollution is shown after the cut in diversion Jan. 1, 1939.

274 The foul and odorous conditions in 1939 extended much farther up toward the Loop than in any preceding year, and the stream was deoxygenated even up to, at times, 18th Street, which was an unprecedented condition. This year (1940) that part of the river is not nearly so bad. The high oxygen demands from Damen Avenue down to Lockport show a very foul condition of the canal. A station below Brandon Pool, but above the Kankakee River, was established in 1939. The results show a very foul condition last summer (1939) and somewhat improved this year.

275 We have made a number of studies on sludge deposits. They show that the oxygen demand of sludge goes on for hundreds of days. We have run them for as long as 700 days at 20 deg. Centigrate in an incubator. The rate of disappearance of oxygen demand is much greater in the first two months, then it slowly tapers off.

In the river, with the increase of temperature in summer you get a putrefactive effect and ebullition of gas, and as the solids are brought up into the water they absorb the oxygen and greatly increase any effect of deoxygenation in that part of the stream. This can go on for several seasons. I should say that possibly 50 per cent of that demand is satisfied in the first summer and 25 per cent in the second summer.

During the winter the sludge deposits lie dormant,
276 and then revive in the summer. That will go along for possibly three or four years, but the major effect will be worn off in two or at most three seasons. These deposits will therefore exert a demand on the water for some time after all sewage is treated.

There are also other sources of solids, from storm-water and the sewage effluents, and all of these effects will considerably delay the improvement in conditions after all sewage is treated. The effect becomes very strong in the early summer with the sudden increase in temperature.

In three years the oxygen demand wears off down to possibly 3 to 5 per cent of its original demand, and that keeps going along for a long time.

277 Sludge may be defined as a muck or putrefactive mass of solids. It is any sort of deposit coming from sewage origin, consisting of organic putrefiable solids deposited in a stream or in sewage treatment plants. By "solids" we mean undissolved material, in a suspended form, and we determine it that way chemically, but it may have any content of water directly in the solids themselves, even up to 98 per cent. In contradistinction to that we talk about dissolved or colloidal solids.

278 In time, sewage treatment will improve the conditions, but the only immediate relief I know of is by increase of diversion, to provide more dilution of the present discharge of solids. There are no other emergency measures that I know of to relieve the nuisance or existing conditions.

Chemical treatment has been with us for many years, and it was the hope that that would relieve the situation. Following the recommendations of the Board of Review we studied this process of chemcial treatment and, frankly, I was disappointed with the results of our own studies. They didn't show as much reduction of B.O.D. as I had hoped. As Mr. Pearse stated, the reduction from an Imhoff effluent was only
279 from 57 p.p.m. B.O.D. to 36 p.p.m. in the chemical effluent, whereas in our investigations of activated sludge we got down to 10 p.p.m., about where our plants operate. The chemical treatment would therefore provide only a minor or an inadequate additional purification of the Imhoff effluent.

For temporary chemical treatment of a condition such as that at the Brandon Road Pool, the only thing that is used to any extent for combating odors is chlorination, and we have considered chlorination for a long time, but it is my conclusion that it is very, very expensive and would be only of doubtful value on such an enormous scale, and with these sludge deposits in the bottom of the channel and in Brandon Pool. I don't know of any other emergency treatment except more dilution.

280 Chlorine, if applied, would quickly disappear. If solids are present it would disappear within ten minutes or so, and then you will lose a great deal of that effect. I don't think it offers a practical possibility for any such problem. It would have to be applied at a number of places in the canal, to be effective. With a flow of 3,000 cu. ft. per second at Lockport,

an enormous amount of chlorine would have to be applied, with only very doubtful possibilities.

Eventual relief will come from installation of ac-
281 tivated sludge treatment as rapidly as possible. I hesitate to say that even then 1,500 c.f.s. will give conditions such as we should have, because I don't think that conditions prior to 1939 were by any means satisfactory. We have Zero dissolved oxygen at Lockport, and would be merely keeping up with what we have had, and would not be improving conditions down there, after the expenditure of all this money for our treatment plants.

Up through 1938, by installation of the treatment plants, we held the status quo, but made no improvement.

282 In studying processes for further treatment of the West Side Imhoff effluent, we have made tests of almost anything that would be suggested to us as modern or recent processes of sewage treatment. We studied new types of biological treatment, rapid filters; variations of activated sludge treatment in which iron salts are used; and chemical treatment on a very large and expensive scale, costing about $150,000. We also studied sand and magnetite filters and activated sludge treatment. Of these processes, activated sludge treatment gave by far the best effluent. There is no doubt that activated sludge treatment is the only thing that can be used; there is no temporary expedient.

283 The activated sludge treatment was studied with a short period of aeration, using only two hours in place of the usual five. We were able to get a low B.O.D. with this short period of aeration.

FLOYD W. MOHLMAN, Direct: 1419-1426.

1420 In previous testimony (Rec. 279) I testified that chlorination would be very expensive and of doubtful value, as a temporary chemical treatment to relieve the nuisance and odor of Brandon Pool. Other chemicals that might be considered are as follows:

1421 Use of sodium nitrate. This is a white powder with formula $NaNO_3$. The oxygen in this compound can be applied to satisfy some of the demand of the putrefactive matter for oxygen, but it has the fol-

1422 lowing deficiencies: (1) the oxygen in nitrate would not be available until all dissolved oxygen had been used, (2) this would eliminate fish life, (3) the cost would be enormous, as the amount required might reach 500 tons per day, costing $17,000, (4) it would fertilize or stimulate the growth of algae and green plants that would later die and putrefy; with putrefactive sludge deposits and zero diss. oxygen, there would be odorous gases liberated; therefore it would not be practicable to use sodium nitrate.

1423 Other miscellaneous chemicals such as potassium permanganate, $K\ Mn\ O_4$, or potassium dichromate, $K_2Cr_2O_7$, have been used for oxidizing organic matter in sewage, but they are far too costly to be considered for this problem.

Ozone, O_3, is used for oxidation and sterilization to a very limited extent in water purification; a few plants in France use it; but it hasn't even been proposed for sewage or polluted waters, and it would be too costly for this situation.

1424 As to the effect of dredging sludge deposits in Brandon Pool, while dredging was going on, there would be disturbance of sludge deposits, and sludge brought to the surface would disseminate odors; 1425 dredging would have to be repeated in the spring for several years until the previous winter's deposits were removed; if deposited on a spoils banks, there would be odors from such deposit, even if overlain by water.

Sludge sometimes contains as much as 98 per cent water and that is a very light material, which flows like water, and can easily be disturbed; it is in a very delicate equilibrium on top of sludge deposits and can easily be disturbed and brought up into the overlying water.

The only practical procedure for relief of the putrefactive conditions in the Main Channel, Brandon Pool 1426 and Illinois River is the diversion of more water for dilution of the putrefactive matter in the water itself, and then as rapidly as possible the construction of activated sludge plants to give us the highest degree practicable of sewage treatment here in the city.

FLOYD W. MOHLMAN.

Cross-Examination, 1817-180.

1819 At the request of opponents, I offer results of chlorine demand studies of water in the Main Channel 1820 as Mohlman Cross-Examination 1. These tests were made July 2 and 3, 1940, and show the amounts of chlorine, in parts per million applied to samples from

the Drainage Canal, to satisfy the chlorine demand and give a test for residual chlorine after ten minutes; the results and temperatures were

Station	Chlorine Demand Parts per Million	Temperature Deg. Cent.
Damen Ave.	1.9—2.2	18
Summit	4.4—4.2	20
Lockport	4.6	22

1822 Tests on chlorination of sewage effluents were made about 15 years ago. I consider that these tests indicated the value of chlorine for our conditions.

1823 I will produce records requested by opponents of results of chlorination of Imhoff effluents at Morton
1824 Grove and Glenveiw. These are small plants, for possibly 2,000 to 4,000 people.

1825 Report of Committee of the American Public Health Assn., "Chlorination in Sewage Treatment", dated 1934,
1826 offered as Mohlman Cross-Examination 2, by opponents.

1828 Chlorine is used in a specific and limited way for the control or prevention of odors. Chlorine will arrest putrefaction in sewage and polluted waters, if used in sufficient amounts.

1829 In the presence of sludge, not enough chlorine could be used to be a satisfactory or dependable method for preventing putrefaction in Brandon Pool in the summer of 1940.

The B.O.D. of sewage at our plants is as follows: West Side, around 100 p.p.m., Souhtwest 170, North Side, 120 parts per million.

1830 B.O.D. is not determined on sludge as a routine procedure; it requires 100 days, or more, incubation; it is made in no sewage treatment plant as a routine test; however, we have research studies up to 1100 days of incubation, results of which will be furnished.

Sludge analyses are made to show moisture content and volatile, or organic, matter; and such results will be offered.

1831 Chlorination to prevent putrefaction in Brandon Pool is impracticable because of the great amount of sludge in the pool, which would nullify any efforts to put in chlorine at the entrance to the Pool. If done, I would recommend addition of chlorine at several places
1832 in the Main Channel and above Brandon Pool, but would have grave doubts that it would accomplish what was intended. I mean that it would not be practicable in terms of results. If I were given the task of prevention of odors, I wouldn't use chlorine.

1833 Assuming chlorine were used, I would apply it at the stations shown in Exhibit 1, i.e., at Damen Ave., Summit and Lockport; the chlorine demands shown, however, would have to be increased very materially to carry along over the sludge deposits. The total requirement of chlorine, to have any assurance that there would be enough to do some good, might be as much as 150 tons per day, costing between $6,000 and $7,500 per day.

1834 When used for killing bacteria in sewage effluents, chlorine might remove from 90 to 99 per cent of the bacteria in activated sludge effluents. Chlorine is not used to kill bacteria in effluents from Sanitary District

plants because the Illinois River is not used as a source of water supply.

Routine bacteriological analyses have not been made at Lockport or Brandon Pool, as such results would be of minor importance as compared with the tests for
1835 dissolved oxygen and B.O.D., which are made daily, in fact hourly. At one time we did make bacteriological analyses, and I have records of thousands of bacteriological analyses made on samples from the lake front and Lockport.

1836 Water of the canal constitutes a menace to health, if accidentally ingested; the effect of nauseous odors is a very definite menace to health, but we are not justified in adding chlorine for fear people might drink the
1837 water. There is always the possibility of bacteria of sewage origin in the water of the Drainage Canal, introduced by storm water; these bacteria could not be completely eliminated by chlorination. The time of flow through the canal and river is so long that the effluents would be re-inoculated, even if chlorinated, and there would be no assurance that the water was of safe sanitary quality.

1838 The Illinois Waterway was polluted even prior to 1900; it has also been polluted since opening of the Drainage Canal on Jan. 17, 1900; my studies have been carried on to determine the degree of intensity of pollution.

If the flow were reduced from 5000 cu. ft. per second to 1500 c.f.s., plus domestic pumpage in both cases, and if the same quantity of water entered a well, the hazard would be nearly three times as great with the lower di-
1839 version. The hazard of contamination of wells would

be greater with the lower diversion, because the concentration of bacteria in the canal water would be greater.

The records of analyses of samples from the Chicago River and Main Channel, shown in Ill. Ex. 31 to 36 inclusive through June, were as follows for the months of July and August, 1940:

1840

	Dissolved Oxygen P.P.M.		5-day B.O.D. P.P.M.		Temp. Deg. C.	
	July	Aug.	July	Aug.	July	Aug.
Ex. 31—Lake Michigan	9.6	8.7	1.3	0.9	19	21
Ex. 32—Damen Ave.	3.7	3.3	5.6	4.2	21	22
Ex. 33—Summit	0.1	0.2	24	23	23	23
Ex. 34—Lockport	0.0	0.1	18.7	15.2	23.5	23
Ex. 35—Marseilles	4.9	3.6	3.9	2.5	25	25
Ex. 36—Chillicothe	5.8	5.0	5.7	6.8	25.5	25.4

If nitrates were present in effluents, they would not be used until all dissolved oxygen is used; nitrates are undesirable and indicate inefficient operation; they would not prevent odor under our conditions.

The average B.O.D. of the North Side effluent was 5.6 in 1929 with nitrates present, and 7.7 in 1939 with no nitrate; in order to produce nitrate in 1929 it was necessary to use 0.8 cu. ft. of air per gallon, whereas only 0.37 cu. ft. was used in 1939; this indicates more efficient operation in 1939; the difference of only 2.1 p.p.m. in B.O.D. in an effluent is a very close variation, the per cent reduction being 95 per cent in 1929 and 93.5 per cent in 1939.

The B.O.D. for canal samples on July 2 and 3, 1940, at the stations where chlorine demands were run, was 26 p.p.m. for July 2 and 29 p.p.m. for July 3 at Summit; and 24 p.p.m. for July [illegible] at Lockport.

I have not made investigations of streams containing nitrates with reference to septic conditions and odors; I do not believe nitrates would prevent odors in the Drainage Canal and Brandon Pool, if large and putrefying deposits of sludge were present in the bottom of that stream. Effluents of Sanitary District plants would not have a lower B.O.D. if nitrates were present, except to the degree discussed previously for the years 1929 and 1939; production of nitrates would require seven hours of aeration, which would mean larger aeration tanks, as five hours is all that is available now.

The North Side effluent contains 1 to 2 p.p.m. dissolved oxygen as it leaves the final tanks; if it contained 5 to 6 p.p.m. plus 5 p.p.m. nitrate nitrogen, and you in-

1850 cubated it in a bottle there would be the equivalent of 20 p.p.m. in potential oxygen, but the nitrates have nothing to do with the B.O.D., which is concerned only wiht dissolved oxygen; dissolved oxygen introduced by cascades may be partly entrained oxygen of microscopic size that escapes and is really not available to satisfy the B.O.D.

1851 The equivalent of nitrate oxygen is N2 to O5, which was computed yesterday at Mr. Naujok's request as 28 to 80, or 1.0 nitrogen equals 2.86 oxygen; the nitrate test for oxygen demand has been abandoned.

Population equivalent of the sewage by-passed at the Southwest Plant cannot be estimated without records, which are to be offered by Mr. Pearse.

1852 I have no data on the amount of hydrogen sulfide in the canal and Brandon Pool, but am quite certain there is hydrogen sulfide present in the canal above the powerhouse and in Brandon Pool.

1853 If chlorine were added to effluents for reduction of B.O.D., it would not reduce B.O.D. load in the canal and Illinois Waterway; tests made in our laboratories showed 1 p.p.m. of chlorine equivalent to 2 p.p.m. B.O.D., but this would not be true in the canal, and chlorination is not the proper way to remove B.O.D.; we have made as extensive tests as have ever been made on this point; these tests were made after chlorination was suggested for B.O.D. removal during the hearings before Master Hughes 14 years ago; chlori-

1854 nation of effluents from all sewage plants as a temporary measure in 1941 and '42 would not result in any practical amelioration of the pollution, because of sludge in the channel and not all of the sewage treated.

Discharging water of the canal over cascades at Lockport would introduce possibly 2 or 3 p.p.m. dissolved oxygen, but with B.O.D.'s running from 25 to 60 p.p.m., the dissolved oxygen would be zero before the water reached Brandon Pool; such a procedure is simple, but would not be successful next summer; we have had a B.O.D. of 50 for a month's average this year.

Conditions at Lockport and Brandon Pool will be better in 1941 because more sewage will be treated.

The data for July and August, 1940, indicate a decreasing B.O.D.; this is to be expected because the sludge deposits partly work out their demand in summer, but during the winter the deposits accumulate and exert their main effect in May and June next summer; while conditions will be definitely better than this year, they will still be very deplorable early next summer in the absence of additional dilution.

In the tests of chemical treatment at West Side, the B.O.D. was reduced from 57 (Imhoff effluent) to 36 p.p.m. by chemcial treatment; this was much poorer than activated sludge, which reduced the B.O.D. to 10 p.p.m.

Chemical treatment at the West Side Plant would not be a small scale operation in which a few barrels of ferric chloride would be dumped into the sewer, but it would need a flocculation tank, a chemical building and much equipment; the operating costs would be as much as for activated sludge; we investigated all of these factors in our experimental plant. Dr. Buswell estimated as well as he could, in the absence of any data from our plant, that 75 per cent of the B.O.D. could be removed, but we operated this large scale

experiment, treating 2 million gallons per day for over a year, in order to find out the facts, and we ob-
1861 tained only 60 to 65 per cent reduction.

After the P.W.A. Board reported in 1935, experiments were started at the West Side plant on further treatment of the Imhoff effluent; the Halvorson biological filter was installed in 1935; several other types of devices were installed; the chemical plant was designed in 1936 and although its construction was not pushed or urged particularly by the P.W.A., it was installed early in 1937 and operated through 1938; so there was a continuous array of experimental work going on, of which the chemical treatment was the largest and most expensive. It was carried out in a thoroughly satisfactory way, on a large scale, and under good control.

Chlorine alone would be ineffective as a means of reducing B.O.D. in the West Side effluent.

1863 Activated sludge installation for the West Side Imhoff effluent would be an extension of the same type of plant at the present Southwest Plant.

1864 I will explain my estimate of the amount of chlorine required for the Canal and Brandon Pool: Mr. Andrew testified as to the presence of sludge deposits in the Canal and Brandon Pool; considering these deposits and their effect in dissipating the chlorine applied, and the long time of flow in the Canal, it was my estimate that the chlorine applied should be 5 p.p.m. at Damen Ave., 8 p.p.m. at Summit, and 10 p.p.m. at Lockport; this equals my estimate of 150 tons per day.

1865 Metering of the Chicago Water Supply would not have any benefit under present conditions, and prob-

ably would not have much influence in the future in preventing discharge of a storm water to the channel;
1866 it would only extend tanks and other equipment for more years; to get nitrates at the North Side Plant the aeration period would have to be extended from the present five hours to at least seven hours, and metering could not accomplish this.

1867 It is a guess to say that 30 per cent of the purification by activated sludge is due to oxidation, and 60 per cent to precipitation, because we don't know just how oxygen requirements are distributed between the solids and the liquid, and we do not determine the five day B.O.D. of sludge as a routine test; therefore the distribution of the B.O.D.—so much to oxidation and so much to absorption on the sludge—is not definitely determined.

1868 Activated sludge spread on land becomes odorous and putrefactive, even if filtered; it must be incinerated or dried; chlorine would not prevent putrefaction of the sludge or filter cake because it would soon wear off, and the odors thereafter might be worse.

1869 Depositing of activated sludge from the North Side in the Main Channel at the West Side was the best thing to do under the circumstances, rather than to discharge it into the North Shore Channel, where it would have settled and odors would have been produced through the city. Sludge could not have been filtered and deposited in lagoons because it was not digested; the filter cake would have created an intolerable nuisance.

1870 Aeration tank treatment of the preliminary tank effluent at the Southwest Plant would produce more

sludge to be discharged into the Channel, whereas by taking it over to the West Side, the Imhoff effluent goes to the Channel and sludge is kept out; this is a better procedure than the suggestions of opposing counsel, that all the flow be put through aeration tanks, and the sludge discharged to the channel.

1871 The Southwest sewage is stronger than the West Side, therefore with a short aeration period of two hours, the effluent would not be nearly so good as the West Side effluent with two hours aeration, as produced in the experimental plant.

1872 If rapid flow occurred through Joliet, as was the case prior to the installation of the Brandon Dam, the odors might be worse because the odorous gases generated in the highly septic sewage above Lockport would be liberated more rapidly in the rapid stretches through 1873 Joliet. I am going on the B.O.D. results at Lockport (Exhibit 34) which showed an enormous increase when the flow was cut; this resulted in much worse odors.

Odors are produced when temperature rises in spring 1874 and the sludge suddenly putrefies. The generating element is sulfate—splitting organisms, present in the sludge, which produce hydrogen sulfide from the liquid sewage. If sludge could be kept out of Brandon Pool in 1941, it would have an ameliorating effect, but the 1875 old deposits plus storm water solids would still be present; all sewage cannot possibly be treated by the end of 1940. About three years will be required to stabilize sludge, 50 per cent the first year, 25 per cent the second, and the balance the third.

1876 Assuming no sludge discharged in 1941, the conditions should be better than in 1940; the worst effect

will be worn off; but tests up to 1100 days show sludge still has an oxygen demand.

1878 Mr. Pearse said he would attempt to answer how much of the present difficulty is due to sludge and how much to untreated sewage from the West Side Plant.

1879 Increase of diversion in summer is practical because that is when the dissolved oxygen is gone, but I think you would have to estimate five months in that period.

FLOYD W. MOHLMAN

Cross Examination: 1882-1887 1902-1918

1882 With reference to the hazard of pollution of wells at Joliet account must be taken of the longer time of flow with reduced diversion, therefore, there would be greater death rate of bacteria, and the hazard to wells would not be three times as great with the lower diversion, but somewhat less than three times; definitely

1886 greater, however, than with a larger diversion, because of the larger number of bacteria per unit volume with lower flow.

The B. coli counts would be greater in 1940 than in 1938, if in proportion to B.O.D. results; B. coli was determined in earlier years but not in 1938, nor by myself in 1940.

1887 The hazard to wells would still be greater in 1941 than in 1938; the well would have been unsafe even in 1938 if water from the canal had found its way into the well and such water was used for drinking purposes.

1902 Experiments on chemical treatment of the West Side Imhoff effluent were made since 1934. Various

combinations of chemicals, copperas plus activated sili-
1903 ca, was developed by research during the course of the experiments. The most efficient chemicals are those which give the best results for the least money.
1904 Pickling liquor was inferior; inert materials such as clay or waste paper were not used; paper had been used in a process investigation some years ago by Dr. Buswell at Dearborn, Michigan, but its use has since been abandoned there, and it is not used in any plant at the present time.
1905 Application of chlorine up to 150 tons per day would be necessary to counteract the effect of sludge deposits. If chlorine were used for odor control it would also be effective for bactericidal efficiency. Chlorination would reduce the bacteria immediately below the point of application, possibly for a half mile, but even with chlorination, ebullition of sludge would
1906 create danger of bacterial contamination of a well, by bringing solids up into the sewage flow.
1908 The degree of hazard to the well would be shown by records of analyses for B. coli; it is not a fact that if any B. coli are found, the water is unsafe; B. coli would have to occur in more than one tube in five 10 c.c. portions to cause one to suspect the water.
1909 It would not be possible to sterilize the water in Brandon Pool; whatever pathogenic bacteria were killed would not reappear. Bacteria of a dangerous nature might live in sludge deposits from 10 to 80 days, possibly longer than that.
1910 Ameliorating measures: hypothetical questions: assume

Air increased to give 5 p.p.m. diss. oxygen and 5 p.p.m. nitrate;

Chemical treatment for Imhoff effluent;

Chemical effluent passed through Southwest Plar ;

All effluents chlorinated;

Chlorine applied above Brandon Pool;

Hydroelectric plant shut down, water passed over cascade;

Sludge removed from Brandon Pool;

No sludge discharged after Jan. 1, 1941;

Sewage from industries and institutions treated;

Would the conditions now complained of be remedied?

Yes, if sludge also were removed from the Drainage Canal; this would have to be done to assure alleviation of conditions in the early part of next summer.

1912 There will be a substantial improvement in 1941 as compared with 1940; but the early summer con-
1913 ditions may not be greatly different in 1941 than in 1940. Budgeting water to obtain merely 500 to 1,000 c.f.s. more in May and June, 1941, would not be nearly enough.

I am not a doctor of medicine, but as a chemist know the characteristics of gases, those which produce odors
1914 and those which do not; have knowledge of toxic concentrations of gases and their irritating effect, but am not qualified as a physician.

1915 Oil as sleek on the Pool would not have the slightest effect to prevent absorption of oxygen.

1916 Chlorine might remove 90 to 99 per cent of bacteria from a clear effluent, but it would not be effective in removing pathogenic bacteria in the presence of sludge.

1917 Hydrogen sulfide produced sickness and affected eyes and irritated membranes of men working in the

operating galleries at the West Side Plant; it was given
1918 off from the sludge vents. I have no records to indicate that any employees of the Sanitary District of Chicago have ever been harmed by handling sludge or sewage in the ordinary course of employment.

FLOYD W. MOHLMAN

Cross Examination: 2411-2463 2492-2519

2414 I have no data on hydrogen sulfide in the water or air at Brandon Pool.

Presentation of data and records requested by opponents:

2412 Chlorination studies.

Exhibit 3, Mohlman Cross-Examination, Reprint of paper "The Chlorination of Sewage and Effluents" by F. W. Mohlman, E. Hurwitz and C. C. Ruchhoft, presented at a Texas meeting in 1929. This was the report of laboratory and plant work at the Des Plaines Treatment Works.

2415 The oxygen demand was reduced 2 p.p.m. for each p.p.m. of chlorine applied, but a further reference, page 29, states that conditions in nature differ from those in the laboratory, in that the residual chlorine will quickly disappear in nature, followed by general infection with bacteria. Favorable conditions will be presented immediately below the outfall but less favorable conditions farther downstream. If considerable dilution is available within a reasonable distance, conditions will be satisfactory, but when several days of flow time occur, the demand for oxygen will be re-intro-

duced and the net effect will be to delay putrefaction. Chlorine is more expensive than biological processes, but where only partial oxidation is required or the elimination of odors essential, chlorine may be the most
2417 practical means of obtaining the desired results. This work confirms the opinion expressed that chlorination in the case of subsequent inoculation or in the presence of sludge deposits is ineffective.

I agree with the conclusions of Baity and Bell that the B.O.D. reductions are permanent, as 15-day incubation shows relatively the same effect as 5-day incubation, provided one restricts this to laboratory tests.

2418 I do not agree with the statement that chlorine exercises a very marked effect in reducing B.O.D.; I would say a very minor effect. The value of the use of chlorine for overloaded sewage plants, or to protect stream quality would depend upon the length of
2419 time over which the effect of chlorine was desired. Any chemist knows that chlorine will destroy odors, but the practical application of this fact depends upon the specific characteristics of the problem.

In my estimates of the application of chlorine to the Drainage Canal and Brandon Pool, chlorine would first be applied to the Canal at Damen Ave. as it is a gen-
2420 eral principle developed in work on chlorination that prevention by pre-treatment is better than destruction of odors after they have been formed; at Damen Ave. there is still some dissolved oxygen in the water, and between Damen Ave. and Summit, most of the sludge has been discharged to the channel; the chlorine demand at Damen Ave. was 2½ p.p.m. with 1-10 p.p.m. residual; to maintain residual over these sludge de-

posits would require a much higher residual than 1-10 —say 2 p.p.m.; to get that I estimate that we would have to apply 5 p.p.m. at Damen Ave., equivalent to 20 tons per day of chlorine.

2421 Before Summit is reached, in a flow time of 30 hours, (put in by Mr. Ramey at request of Opponents), all chlorine would be gone, and more would have to be ap-
2422 plied; the time of flow from Summit to Lockport is 62 hours, the distance 20 miles; the chlorine demand with 1-10 p.p.m. residual was 4 to 5 p.p.m.; to carry over that distance, I would apply 8 p.p.m. at Summit, equivalent to 50 tons per day.

At Lockport the chlorine demand with 1-10 p.p.m. residual was 5 p.p.m. I would apply 10 p.p.m. to carry over Brandon Pool; equivalent to 75 or 80 tons per day.

2423 These applications would total around 150 tons per day.

2424 If chlorine were applied only at Lockport, the results would be more uncertain than if chlorine were applied also at Summit and Damen Ave., because of decomposition in the channel; but if applied only at Lockport, to protect Brandon Pool, the amount required would be more than 75 tons per day and less than 125; if sludge were removed at Lockport there could be a further reduction.

2425 (Cross-section of Drainage Canal offered as Mohlman Cross Examination 4.)

2428 The estimate I have given for the amounts of chlorine to be applied was based on a consideration of the records of dissolved oxygen and B.O.D. at Damen Ave. and Summit, introduced previously as Ill. Ex-

hibits 32 and 33. The chlorine would be applied continuously.

2429 The effect of chlorine would wear off in a number of minutes or an hour, if only enough were applied to satisfy a residual of 1-10 p.p.m.; some of opponents witnesses were estimating even less than this; to main-
2430 tain the effect over a number of hours, much larger amounts would be needed; I agree with Mr. Enslow that it might be desirable also to add lime to make the chlorine effective over a longer period.

2431 I testified on direct that I didn't consider chlorination to be certain and effective method of eliminating odors, in the presence of sludge; after the present deposits lose their potency by years of action, then chlori-
2432 nation would offer much more hope of success. If sludge ceased to be deposited, you would need a greatly reduced quantity of chlorination to take care of accumulations that had not yet lost their potency. However, the sludge volumes now present have not lost their potency; I will present an exhibit later on this matter.

2433 Use of chlorine for odor control at Morton Grove and Glenview: Exhibit 5, Mohlman Cross Examination, introduced at request of opponent's counsel, shows the result of chlorination of Imhoff effluents for odor con-
2436 trol, at Morton Grove and Glenview, in 1939; the results show up to 21 p.p.m. used at Morton Grove in August, and 7.8 at Glenview, where the sewage is much weaker.

2440 Exhibit 6, Mohlman Cross Examination, consists of a table of analyses and a diagram which shows the course of oxygen demand of sewage sludge up to a

period of more than 1100 days; the sludge was covered with river water from the Illinois River at Peoria, where the work was done in our laboratory as a research study. The curve is plotted according to the B.O.D. of the volatile, or organic matter, in the sludge, and the downward slope shows the rate at which the
2441 organic matter is stabilized, and loses its potency; quite a reduction goes on for 300 days, after which there is a very slow reduction.

In order to check against sludge in the Main Channel, other work was started Dec. 14, 1936, on sludge collected at the Lockport Power House; this was run for 300 days, the results are offered in a table of analyses and a diagram, as Exhibit 7, Mohlman Cross Examination. The loss of potency as shown by this curve is quite similar to that shown in Exhibit 6.

2444 These curves show as closely as one can in any research study the effect of time on the loss of potency of sludge.

2445 Exhibit 8, Mohlman Cross Examination, is a photostat of an editorial written by me in the "Sewage Works Journal" for May, 1938, page 613; it includes a discus-
2448 sion of the results I have just offered as Exhibit 6. This editorial discusses the significance of the curves I have introduced, and the question of the influence of sludge deposits in streams.

In addition to this editorial, I have here a translation from a book of Dr. Imhoff's, which I offer, plus a photostat of some pages from a book, as Exhibit 9, Mohlman Cross Examination. Dr. Imhoff has visited here and we have discussed the question of pools; I visited him two years ago in Essen, where he has a somewhat simi-

lar problem of pools in the Ruhr River; I have translated excerpts from his book relating to sludge deposits. Curves shown in the photostat from the book include
2454 values of B.O.D. of sludge deposits taken from my Exhibit 6; he shows for the first summer of 120 days a 55 per cent reduction, then the sludge lies dormant through the winter; the second summer he shows a further 11 per cent, and 5 per cent the third summer.
2456 Referring to Exhibit 7, there was a two-thirds reduction of the B.O.D. in 196 days; this was at 20 deg. C., and in the river the temperature does not remain at or over 20 Deg. C. for as long as 196 days; temperature has quite an influence.
2457 Mr. Pearse showed in an exhibit 54,000 tons of sludge discharged to the channel in 1939, and 19,000 tons in the first seven months of 1940; the 1939 sludge would lose 50 to 55 per cent of its potency by next summer, and 20 per cent the second year; in 1941 the sludge would have from one-half year to two years of decomposition, and I took that into account in the estimates I have made of the effect of sludge on the requirements for chlorine and the oxygen demand of the deposits.
2461 The time when sludge was discharged must be taken into account; one must consider that the major effect is concentrated in the early summer when the temperature rises.
2462 I believe it would be closer to five months than three for a complete summer's control.

FLOYD W. MOHLMAN

Cross Examination: 2492-2519

2492 I have no data prepared on bacterial remvoals by chlorination at the Des Plaines Treatment Works.

In our sampling of the Chicago River and Drainage Canal, a chemist visits the sampling stations once daily; if the sampler is not using proper technique, it is corrected; reliance is placed on the average of 24 daily
2494 samples; samplers have no special training; a sampler was recently killed; the report by Klassen and Wisely on Illinois River work refers to samples being thrown out as not representative; these samples were taken by the State samplers; they used the Sanitary District results at Peoria and Beardstown and state on page 577 of this publication that the procedure used by the Sanitary District laboratory is standard in
2499 all respects.

2500 Exhibit 6, Mohlman Cross Examination, refers to sewage sludge from the Peoria sewage treatment works, primary and activated sludge; sludge for the next Exhibit, No. 7, was taken from the Drainage Canal at Lockport, collected in a bucket in the forebay of the power house, the curve is similar to that in Exhibit 6; the sludge was in the water the number of days it took to reach there from the Southwest Plant.

2501 Questions have been asked by the Master and Mr. Naujoks concerning the B.O.D. of sludge and effluents discharged to the channel; as testified previously, B.O.D. of sludge is not determined as a routine test, but we do have determinations of volatile, or organic suspended solids on both sludge and sewage, and in order to pre-

sent a record of the sources or organic matter dis-
2502 charged, I have prepared Exhibit 10, which includes tables and a chart. Exhibit 10 shows computations for
2509 the years 1939 and 1940 of the discharge of volatile solids, in tons per month; the first table shows the tons discharged as sludge, the second table the tons in the West Side Imhoff effluent, the third table the tons in the Southwest effluent, and the fourth table the tons in untreated sewage. The untreated sewage was esti-
2511 mated by taking the difference between the total water pumpage and the amount of sewage treated.

This exhibit shows that an effort has been made with the facilities available, to keep sludge out of the channel and to treat the raw sewage; this made it necessary
2512 to discharge more West Side effluent and partially treat Southwest effluent, but this seemed more desirable than to discharge sludge or raw sewage; the solids from the West Side will not decrease appreciably until activated sludge is installed.

2513 The large amount of rain in May, 1940, increased the sewage flow so that it was equal to the water pumpage, but that does not indicate that all of the sewage in dry weather would be treated; the general decrease through the year, however, is apparent; sludge was discharged until July; this and the sludge discharged last winter will have a very noticeable effect on the channel next summer; however, the total tons of untreated sewage deposited for the two years preceding July 1, 1941 will be considerably less than for the two years preceding July, 1939; a table could be made up showing the sludge deposited for the two years preced-

2514 ing July 1, of 1939, 1940 and 1941; the latter year would involve some assumptions. (See Exhibit 13)

There has been a steady decrease, except for the increase in June and July, 1940, of the discharge of solids in the effluent from the Southwest Plant; the general average is 88 tons in April, 55 in June, and 76
2516 in August; the sewage treated in July was 287 million gallons per day, which was less than the average in May, June or August.

2517 With reference to sampling errors at Pekin, in the report of Klassen and Wisely it is stated that they found it difficult to select a proper sampling point at Pekin because the Peoria pollution was not evenly
2518 mixed, and therefore the results at this station were subject to considerable question; there was no question concerning the manner in which the samples were collected by the samplers.

In that particular station (Pekin) we made cross sections of the river, took current meter readings in each section, collected samples in each section, and had a weighted analysis to tell us where the best place would be for taking samples; this was in the Sanitary District work, they indicated they weren't satisfied that they had the best place for sampling.

FLOYD W. MOHLMAN

Re-Direct: 3278-3312

3278 A discussion of Howson Exhibit 10, in parallel columns, is offered as Mohlman Exhibit 11. There is a con-
3284 trast between Mr. Howson's first item, increase of diversion from 1,500 to 3,500 cu. ft. per sec., and the

other items, which refer to increase of nitrates, re-aeration at Lockport by cascades, and regulation of flow. Increase of diversion results in dilution of the polluted and nauseating conditions, practically halves the B.O.D.; none of the other suggestions can accomplish this.

Mr. Howson's suggestion refers to increased air at the North Side and Calumet plants, to produce nitrates; increased air alone will not accomplish this, but it also takes a longer aeration period, 7 hours instead of 5 hours; that is not available; nitrate production at the North Side would give no measurable improvement because it would only stimulate growth of plants in the North Shore Channel, which growth is now prolific; the plants break loose and decompose; the dissolved
3286 oxygen is quite low at the lower end of the North Shore Channel; the diluiton would be from 300 cu. ft. per second at the North Side to 3,000 at Lockport; so it seems the beneficial effect of this suggestion is practically negligible.

3287 Reaeration at Lockport by cascades, Item 3 in Mr. Howson's exhibit, would create a local odor; the loss of power would be $1,500 per day; I don't agree that 6-¾ p.p.m. of dissolved oxygen would be absorbed. Because of the high B.O.D. and the anaerobic condition of the water not more than 3 p.p.m. would be absorbed and that would be used up very quickly and have no appreciable beneficial effect at Brandon Pool.

3288 Item 4, an increase of water in summer, has merit because it recognizes the fact that dilution is beneficial, and the suggestion would give 1,000 cu. ft. per second more than we have been flowing.

3289 If the budgeting of flow could give 4,200 cu. ft. per sec. in summer, the extra 1,000 cu. ft. would provide 43,200 lb. of oxygen without cascades, but this would equal only 1.9 p.p.m.; however, the diluting effect would be helpful.

3291 A discussion of Howson Exhibit 11, in parallel col-
3298 umns, is offered as Mohlman Exhibit 12, I have attempted to sift these proposals with reference to their practicability and the degree to which they would relieve the situation at Brandon Pool.

Mr. Howson has estimated the 5-day B.O.D. at Brandon Pool as 25 p.p.m.; although we have results there last June up to 39 p.p.m., I would consider 25 p.p.m. a fair average.

The second item, in which is given the B.O.D. for the effluents from the West Side and Southwest Plants, refers to the B.O.D. at the outfalls; the B.O.D. at Lock-
3299 port would be much lower because of the time of flow of four days; the relation would be 27/68 times the values he has given; therefore, these contributions to the B.O.D. at Brandon Pool have been estimated too high, and the other sourec of B.O.D., sludge deposits, has been estimated too low; I have not made estimates on this basis, possibly Mr. Pearse has values for sludge demand; I have not used this method to show sources of B.O.D. as I am not satisfied with any of the computations.

3301 The third item of Mr. Howson's Exhibit 11, refers to the desirability of eliminating by-passing of part of Southwest flow after primary treatment; I do not consider this as by-passing, as it is not raw sewage, but settled effluent.

Item 4 on Howson Exhibit 11 refers to the desirability of keeping sludge out of the canal; I believe Mr. Howson has estimated a very low value of B.O.D. of sludge deposits. In my opinion they will exert an influence twice the 105,000 lb. shown in Howson Exhibit 11, for the first season and 105,000 the second season, and 50,000 the third season.

3302 Item 5, referring to chlorination, shows an estimate of removal of 12 p.p.m. of B.O.D. in the channel by application of 6 p.p.m. of chlorine; I do not agree that this is possible; I do not consider chlorination to be a proven method for removal of B.O.D. as compared with known and used methods of sewage treatment; where chlorine is used wtih settled effluents, as at Detroit, Cleveland, Buffalo and Toledo, the purpose is not to remove B.O.D., but to kill bacteria. Mr. Howson does not include in his Exhibit 11, the suggestion of using chlorine for the West Side Effluent; this suggest-

3303 ion was made by Mr. Enslow (page 2023 of the record) who stated that "I began thinking how simple it would be to chlorinate that effluent as well and get reduction in oxygen demand and this delay in bacterial effect a good deal more economically than with chemical precipitation. I was rather thinking out loud now, but that is my thought in the matter". I submit that this is rather snap judgment concerning choice of a method for treating the West Side Imhoff effluent; I reje ' it as totally incapable of doing what is claimed for it.

I have prepared a tabulation of volatile solids discharged to canal, offered as Exhibit 13, Mohlman Cross Examination. This exhibit is an extension of Exhibit 10, offered earlier; the present Exhibit 13 shows an-

nual results for the years 1938 through 1943, (esitmated
3306 after August, 1940); I would call attention to the reduction in the West Side effluent at the end of 1942 because of the operation of activated sludge there at that time; there is a sharp reduction in 1943, indicating that at that time conditions can be expected to become
3309 materially better. I call attention to a statement on the exhibit referring to the flocculation of solids from the Imhoff effluent, this causing some sludge demand in the channel; this will be a factor to be considered seriously through 1942, after that the activated sludge effluent will not have that effect.

The Master: I would be interested to see the results on this same basis for earlier years, say 1936 and 1937.

3311 Ans. I will be glad to give you those figures; (offered later as Mohlman Exhibit 15.)

One more comment—I note in Mr. Howson's Exhibit 14, which will be discussed by Mr. Pearse, that on Line 4 he shows the B.O.D. at Lockport in pounds; this does not show the actual condition of the water unless you take the flow into account, and show the results in parts per million; one might assume from the record of pounds that the condition of the water has been steadily improving since 1938, but the parts per million, that is the actual analyses, show that it has been much worse since 1938; the p.p.m. were 17.3 for 1938, 30.2 for 1939, and 20.6 for 1940; his estimate for 1941
3312 shows 7.3 and for 1942, 4.8; I believe he is estimating an optimistically low B.O.D. for those two later years, because of the B.O.D. from old sludge deposits.

3382 There are no results of tests for hyrogen sulfide made by the Sanitary District or by others, that are

known to me, except those that have been testified to in this hearing.

FLOYD W. MOHLMAN

Exhibits: 3530

3530 Mohlman Exhibits 14a to 14e, inclusive, are as follows:

14a. Basis for Estimating Addtional Diversion Needed in Summer.

14b. Analyses at Lockport and Diversion, 1940.

14c. Proposed Increase of Diversion—Actual Increase to be Modified in Accordance With Results of Sanitary District Analyses Submitted to U. S. Engineers—Year 1941—Cu. Ft. per Second.

14d. Proposed Increase of Diversion—Actual Increase to be Modified in Accordance With Results of Sanitary District Analyses Submitted to U. S. Engineers—Year 1942--Cu. Ft. Second.

14e. Basis for Estimating Additional Diversion Needed in Summer for Ameliorating Conditions in Brandon Pool.

Mohlman Exhibit 15, is as follows:

Record of Dry Volatile Solids Discharged to Canal in Sludge, Raw Sewage and Effluents—Tons per Year.

FLOYD W. MOHLMAN

Re-Direct: 3589-3628

3589 Preliminary steps were taken by me to carry out the sampling and analytical work for the 10-day flushing test. The order was dated Nov. 25, 1940. Prior

to this date a scheme of sampling and analyses was worked out and discussed with Mr. Warrick, and his suggestions were followed. He visited Brandon Pool with me twice, once before and once during the test.

3590 Samples were collected from Nov. 17 through Dec. 17, 1940, comprising five days before the test, ten days during the test, and five days after the test. The scheme of sampling and analyses was described in a letter of instructions dated Nov. 28, 1940, which I offer as Mohlman Ex. 16.

3594 Samples were collected at 14 stations, extending from the Mouth of the Chicago River to Chillicothe. The most important stations were those at Cass St. in Joliet just above Brandon Pool, and at Brandon Bridge, just below the Pool.

The original data of the test are included on 80 pages of typed forms comprising some 8,900 results. These data are summarized in the Report in 23 pages of tables.

3595 The original 80 tables are available but are not included in the Report.

I suggest that the "Summary and Conclusions" be read and then I will explain the detailed data therein. I offer the Report as Mohlman Ex. 17.

3597 The Report is divided into discussion first of suspended solids, which form sludge; second, dissolved oxygen; third, B.O.D.; and finally, a survey of sludge deposits before and after the test.

3598 The Des Plaines River enters below Lockport and above Cass Street. Most of the tests for dissolved oxygen were made hourly.

The suspended matter at Lockport averaged 15 to 19 parts per million before the test. On the first day of

the test this increase to 327 p.p.m., and the maximum of 491 p.p.m. occurred on the second day. After the test
3599 the results again returned to 17 or 18 p.p.m. At Cass St. the results were slightly higher than at Lockport. The maximum at Cass St. was 504 p.p.m. at Brandon Bridge the results before the test were 14 to 19 p.p.m. On the first day the average was 75 p.p.m., and the maximum of 109 p.p.m. was reached on Dec. 7-8, the sixth day of the test.

The parts per million are computed to tons per day,
3600 showing 75,990 tons of suspended solids and 24,190 tons of volatile suspended solids carried past Lockport, 84,010 total and 27,067 volatile past Cass St. into Brandon Pool, and 21,123 tons total and 7,512 tons volatile carried out of the Pool. These results show that 74.8
3601 per cent of the total suspended solids and 72.2 per cent of the volatile suspended solids were deposited in the Pool.

The increase of suspended solids was very rapid at the start of the test. At Cass St. the suspended solids increased from 25 p.p.m. at noon, when the flow was increased, to 526 p.p.m. at 6 P. M. At Brandon Road the increase reached 131 p.p.m. at 1 P. M., thereafter running 88 to 90 p.p.m.

3602 There was an 86-fold increase in suspended solids and a 32-fold increase in volatile suspended solids at Cass St. for the first day of the test, as compared with the day before the test. The results show a great variation from hour to hour, demonstrating the necessity for frequent samples.

The Brandon Bridge results never reached those at Cass St. by quite a bit. There was a slight increase at

3603 Brandon Bridge on Dec. 7th, the day the level was lowered one foot; but even on that day the results were only half those at Cass St.

It appears that 506 times as much material was carried out of the Drainage Canal during the test as would have been transported in one day under dry weather normal winter conditions with a diversion of only 1,500 c.f.s.

3604 The results show that considerable material was carried out of Brandon Pool during the test, but considerably more was deposited in the Pool.

In my Exhibit 15 it was estimated that 76,000 tons of volatile solids would be discharged into the Channel from all sources in the year 1940. About 35 per cent of this amount was carried out of the system at Cass St. during the test. The actual sludge deposited in the Channel in 1940, as volatile solids, was about 15,000 tons.

3605 Results at Marseilles and Chillicothe during the test showed a rather moderate increase in solids, mostly silt. There was hardly an appreciable increase in B.O.D. and suspended matter that far downstream.

For stations above Lockport, results indicated that there were no very large or extensive deposits of sludge above Summit. Results at Chicago Avenue indicated no large amount of sludge in the North Shore Channel.

3606 Turbidity results are of no particular significance.

3607 Dissolved oxygen results in Brandon Pool were somewhat higher than at Cass St., but at the end of the test the dissolved oxygen in the Pool samples slowly decreased from an average of 10.3 p.p.m. on Dec. 12th to

8.1 p.p.m. on the 15th to 2.7 p.p.m. on the 16th, and 0.9 on the 17th.

A similar decrease occurred at Lockport. The table preceding page 15 of the Report shows flows and dissolved oxygen at Lockport in December of 1938, 1939
3608 and 1940. In 1938, with a flow of 5,469 c.f.s. the oxygen increased to 8.2 p.p.m. at the end of the month. In 1939, with a flow of 3,469 c.f.s., the D.O. was very low and increased to 3.5 to 4.5 p.p.m. at the end of the month. In 1940, the D.O. increased from 1.2 p.p.m. the first day of the test, Dec. 2, 1940, to a maximum of 10.7 p.p.m. the day after the test ended. Thereafter the D.O. decreased very rapidly and came down to a few tenths p.p.m. at the end of the month.

Results through Jan. 7, 1941, show only 0.7 to 1.0 p.p.m. D.O. to be present. A longer period of observation will be needed to demonstrate whether this will increase. We might expect conditions at Lockport ought to be improved because of the flushing out of the large
3609 tonnage of sludge, but I am disappointed that more D.O. hasn't been present these last several weeks, because there is no question that a little later on when the weather begins to get warmer the D.O. will be less and will get down to zero pretty quickly. It is a little disturbing to see those low dissolved oxygens at Lockport in the middle of the winter.

3610 The dissolved oxygen results in Brandon Pool are shown in Appendix F and Fig. 2 of the Report. Samples
3611 above the ice fender wall were not collected until Dec. 6th. At Brandon Bridge the dissolved oxygen increased possibly 7 p.p.m. This was because of passage over the dam under winter conditions. Under summer

conditions, according to our records, we rarely find more than 3 p.p.m. increase in D.O. by passage over Brandon Dam.

3612 The D.O. at Lockport Dec. 17th was 2.6 p.p.m. as compared with 1.2 on Nov. 27th; there was also an increase at Cass St., but a decrease at Brandon Bridge. These results would indicate that the test had done no good in so far as creating any more dissolved oxygen.

3613 The consideration of dissolved oxygen is not as important in winter as summer, but if as low values are reached in winter as have been shown at Lockport, it is getting pretty close to the danger point with refer-
3614 ence to putrefaction. However, the main object of this test was to move the solids. The presence of D.O. during the test may have had beneficial effect on the solids because they were washed with an oxygen-rich water.

3615 The results of determinations of B.O.D. showed that the material carried out of the Pool was of more organic character than that carried in. Based on suspended solids, 25 per cent that entered was carried out; 27.8 per cent of volatile suspended solids; and 47.2 per cent of the B.O.D.

3616 In order to check on the amount and character of sludge deposited in the Pool, I had samples collected, before and after the test, by a crew of men using a pitcher pump with a suction hose that can be lowered to any definite level.

3617 The first sample was collected Nov. 1, 1940, and the second trip was made Dec. 27, 1940, long enough after the test to allow conditions to reach equilibrium.

We made soundings, using the disc of the U. S. Engineers. In most cases the disc sank lower than the most dense sludge we were able to collect on Nov. 1st, and therefore I conclude that the soundings pass through the lighter sludge and down into the thicker and denser sludge.

3618 The putrescibility of foulness of the sludge is shown by the B.O.D. per gram of volatile solids, and in eight out of ten samples this was greater after the test than before. This indicates the surface sludge was somewhat more putrescible than before the test.

3619 The soundings indicated a fill of about two feet of sludge. At 88 per cent moisture the suspended matter deposited in the Pool would equal a fill of two to two and one-half feet, and would be equivalent to about 500,000 cu. yds., or an equivalent number of tons. This was taken out of the Drainage Canal and therefore water coming from the Lake should contain a higher
3620 level of dissolved oxygen. However, the results at Lockport have not as yet shown an increase of D.O. If enough water is diverted to maintain oxygen at Lockport, it should benefit Brandon Pool. But in my opinion this cannot be done unless the diversion is increased as in the suggestions I made in Exhibit 14.

3621 I believe it would have been slightly more helpful if the Pool had been lowered five feet, instead of one foot, but I can't believe it would make a great deal of difference in this cold weather, when gas is not being given off and it is not in ebullition. There was some gassing after the test but none before. Such ebullition is much more marked in warm weather.

3623 Lowering the Pool levey by five feet would give greater velocity, but that would not be a very great factor. If gas were being given off, it might bring sludge to the surface, but it wouldn't occur anywhere near as much in winter as in summer. Even in summer the sludge would only rise and fall again, if there were a flow of only 3,100 c.f.s.

3624 The foot lowering during the test didn't do much. On that day the tonnage going past Brandon Pool was only half that coming from Cass Street.

3625 The results of the test have led me to believe that conditions of odor production have been concentrated in Brandon Pool, that sludge of greater putrescibility has been put in it, and that the need for relief will be about the same next summer.

3626 It is my judgment that within the next month or two the dissolved oxygen at Lockport will again be down to zero. If diversion were increased through the summer and oxygen were maintained at Lockport, there would be a better chance of getting the beneficial effect right at Brandon Pool. If nothing more is done and the Supreme Court doesn't increase the diversion, I would say that conditions at Joliet next summer would be about the same, or worse than if the 10,000 c.f.s. had not gone through for ten days.

3627 Down stream, as far as Peoria, there was hardly a noticeable effect from the test. There was always a large excess of dissolved oxygen, even below there, as shown by tests made by the State Department of Health.

F. W. MOHLMAN

Cross Examination: 3699-3777

3699 The maximum width of Brandon Pool is about 1400 ft. and the depths vary down to the sludge level of around 18 to 20 ft. From the surface of the sludge to the bottom of the Pool the density of the sludge in-
3701 creases. The depth where you detect the sludge by soundings depends upon the weight and shape of the sounding apparatus.

It is generally true that the higher moisture content is at the surface of the sludge and the moisture content decreases as you go down into the sludge.

3702 In winter there is a sharper line of demarcation between sludge and water than in summer. There is a greater degree of mixing or intermingling of sludge with the overlying water in summer because the temperature induces formation of gas in the sludge, which lifts the solids, and when the gas is liberated the solids will again drop.

3703 The suspended solids in the West Side effluent would be mixed with silt and of different character in the Pool than when discharged. Only analyses to show the avidity for oxygen will show the degree of putrefaction of the sludge.

The tests we made indicated only about a foot and a half or two feet of active flocculent sludge in the Pool in winter.

3704 Out of a total depth of 18 ft. of water, the upper 5 ft. is relatively clear compared to the sludge layer below.

3705 If you lowered the Pool level five feet you would get comparitively clear water, as we found a maximum of 105 p.p.m. suspended solids in our samples at Brandon Bridge, whereas the sludge at the bottom of the Pool contained from 40,000 to 120,000 p.p.m., therefore
3706 400 to 1,200 times as concentrated. Therefore skimming off the top water would not in any measure be equivalent to getting rid of the sludge that is on the bottom of the Pool.

The top solids would not be much more avid for oxygen than the bottom sludge—approximately in the ratio of say 300 milligrams oxygen for bottom sludge compared with 380 as a maximum for the Lockport sludge, as shown in Mohlman Ex. 7.

3707 The sludge still has 75 per cent of its original potency.

The lighter flocculent sludge has greater avidity
3708 for oxygen than the heavy dense sludge. There is only a foot or two of this lighter sludge in winter, but a greater depth in summer due to mixing by ebullition of gas.

3709 Attempts to raise sludge in winter by dragging weights with boats would not be successful, in my opinion. Sludge is not like a soluble material, sugar, which diffuses so that the concentration is the same from top to bottom. Sludge is insoluble and is graded according to its specific gravity.

With that depth of 18 ft., I think it would be quite
3710 difficult to stir the sludge in winter to a degree that would bring it up into the water. After you get it in the water, it will again sink if you don't have enough velocity to sweep it through.

No attempt was made to stir up the material during the 10-day test by dragging weights from boats, or any other method. I don't think such a procedure would have helped appreciably, for the reasons I have given. In winter it would have to be violently stirred, whereas
3711 in summer if you once gave it a good stir, the gas and other actions would help to bring it up. Even then, if you don't have the velocity to carry it through, it will
3712 sink again. If you got it into the upper five feet and then didn't wash it out, it would be more prone to give putrefaction and odors then if it hadn't been stirred up. I think it would increase odors, since it would not be oxidized nor removed.

3713 Several factors entered into the failure of the 10-day test to give the results hoped for. It would have had more chance to succeed in warm weather, at a time when the sludge was in a condition just ready to rise. In winter the only way in which it could wash through Brandon Pool was by opening some of the gates and getting a concentrated effect through the center part of the Pool that would carry sludge through.
3714 As the test came out, the current induced wasn't sufficient to carry through the material that came in from the Main Channel. However, 28 per cent of the suspended matter and 47 per cent of the B.O.D. carried through, but more putrescible material was left in the Pool than was there before.

3716 I have no data on the actual velocities in the Pool during the test. Mr. Ramey looked after that.

3718 The general level of the flocculent sludge in the Pool in winter is from 18 to 20 ft. below the water sur-
3719 face. Flocculent sludge contains from 99 down to 90

per cent moisture. In summer I would estimate that this potent, active material would not be closer than
3721 15 ft. to the surface of the water. The total depth of the Pool is approximately 24 ft. The summer sludge will bulk a little and I might as well guess 12 ft. from the surface as 15 ft. I will find out next summer.
3723 The gates at the lower end of the Pool were opened close together, over a distance of about 80 ft.
3724 The increased velocity during the test took some of the sludge out of the Main Channel, but not all of it.
3725 The maximum lowering of the Pool was one and one-half foot. Any further lowering would, in my opinion, have produced only a minor increase in the solids carried out of the Pool. With the lowering of a foot and one-half, twice as much sludge was carried into the Pool as out, therefore I don't think a further lowering could overcome that large differential and carry
3727 out more than was brought in. This is my best opinion but I am quite willing to defer to Mr. Andrew's opinion on that if he has a different view.
3728 The maximum hourly result at Brandon Bridge was within 20 p.p.m. of the minimum hourly result at Cass St., but you must take the average for 24 hours, not single selected results. The average results for
3730 the day of maximum lowering showed that only half the tonnage that came into the Pool was carried out. The average difference between Cass St. and Brandon Bridge on this day was 30 to 35 p.p.m.
3731 The reduction of B.O.D. of 47.2 per cent does not apply only to the solids, but to all of the flow, liquid as well as solid. The sludge demand goes on for months

and years and must be considered on a different basis from the flowing material.

3732 There has been an improvement in the Main Channel and a deterioration in Brandon Pool. If you take the entire system, there has been an improvement due
3733 to the removal at Brandon Road of 21,112 tons of suspended solids and 7,512 tons of volatile suspended solids. One-fourth of what was moved was carried out of the Pool.

Mr. Ramey can give the amount of water that went
3734 through the wheels at the Lockport Power House and the value of the power produced.

3735 The term "volatile suspended solids" means the loss of solids when a dried sample of sludge or dried suspended solids are ignited in an electric furnace at 650 deg. Centigrade. It is the putrescible part of the
3736 solids as the other part, mineral matter, does not putrefy. Even some of the volatile matter does not putrefy. For example, in nature if a dead animal putrefies and everything returns to the soil, you still have a humus material there that is still organic but not putrefactive. The rate at which volatile, or organic matter is stabilized is shown by the curves I introduced (Mohlman Cross Ex. 6 and 7).

3737 There is some degree of aeration of the Southwest effluent that enables it to pick up dissolved oxygen
3739 before it enters the Main Channel. At the Lockport Station, during the test, on Dec. 2-3 there was 1.6 p.p.m. dissolved oxygen, whereas at Cass St. it was 0.7 p.p.m.
3740 The flow passes through the turbines at Lockport. The decrease in dissolved oxygen is due to the amount of sludge picked up between Lockport and Cass St., an

increase from 73,990 tons at Lockport to 84,010 tons at Cass St. This increase was due to agitation. The sewage
3741 of Joliet comes in below Cass St. The substantially greater content of dissolved oxygen at Brandon Bridge during the test was due to the aeration in passing over Brandon Dam and through the gates. This was under winter conditions, and the increase was about 7 p.p.m. We have made many tests in the summer and had
3742 never found more than 3 p.p.m. This was with a flow of 3,000 c.f.s., or with 1,500 c.f.s. diversion.

I would think the opportunity for aeration would be greater with a thin layer going over the dam with 3,000 c.f.s., than with a thick layer going over at 10,000 c.f.s. "Aeration" means the rate at which you can force oxygen from air into a dissolved state in water, whether
3743 you do it by blowing air in, or by passing over a dam, or by inducing agitation. It is a fact that the thinner the layer of water flowing, the more rapidly it will take up oxygen. You would get more tons of oxygen into a larger volume of water, agitated, but you would get more in a thinner film in parts per million.

3744 In the Report of the Flushing Experiment, the increase of dissolved oxygen with 1,500 c.f.s. diversion, from Cass St. to Brandon Bridge was from 1.1 to 8.5 p.p.m., whereas during the test, the increase was from 8 or 9 p.p.m. at Cass St. to 12.1 p.p.m. at Brandon Bridge. Thus the larger flow absorbed less oxygen.

3745 Aeration by cascades would have to be practiced at Lockport, above Cass St. The 10-day test records show the aeration that took place at Brandon Dam. At Lockport, where the water goes through the tur-

bines, there was no dissolved oxygen picked up by aeration.

For the third time, I want to point out definitely that this is under winter, and not summer conditions.

3746 I consider that the condition of Brandon Pool was a menace to the health of the people of Joliet in 1940.

3747 The pickup of oxygen depends on the temperature of the water. In winter, for example, I show up to 14.8 p.p.m. dissolved oxygen at the Mouth of the River, whereas in summer, it is only about 8 p.p.m. Likewise the absorption varies as to the degree of unsaturation. The ebullition of gases is caused by production of gas

3748 by bacterial putrefaction. The production of gas depends almost entirely on the temperature of the water, which is dependent on the temperature of the air.

3749 I believe that the only solution to this problem at Brandon Pool is increased diversion from Lake Michigan. No other temporary measures proposed in this case compare with it in efficacy.

3750 With the present flow of around 3500 c.f.s. I do not believe that any of the suggestions brought up and discussed would be successful. None of them were really new to us. We had analyzed their practicability, efficacy, cost, and time to install, and we had concluded that none of them offers the hope, I would say almost the certainty of improvement, that we could get by additional diversion.

3751 Assuming that no increased diversion would be granted, it is my opinion that the other ameliorating measures proposed do not have enough possibility of success to warrant the attempt to do any of them, or all of them together. I have no reservation in my mind

of any other remedies that haven't been proposed. I mentioned the use of chlorine and nitrates myself and stated the enormous cost of those measures and other witnesses took up the question of time.

3753 Leaving out the element of time for installation, I would not consider the ameliorating measures would correct conditions next summer. As a permanent solution I would say complete our activated sludge plant as quickly as possible.

3754 The best suggestion for amelioration, next to the immediate use of water, was the idea and hope we could get the sludge out of the Channel and downstream, as discussed in this hearing. Since that has not been done, if no increase of water will be available next summer, I would say we would just have to wait until the sewage plants were completed.

Sewage has been discharged into the waterway for
3755 forty years. Analyses to show conditions at Lockport since 1926 have been put into the record as Ill. Ex. 37. Records of tonnages of sludge have been shown in Mohlman Ex. 13a back to 1936 and of pollution in Pearse Ex. 61.

3759 Records in pounds per day would indicate that 1940 was much better than 1938, but in parts per million 1940 was much worse than 1938. This is because of the diversion of 5,000 c.f.s. in 1938 and only 1,500 c.f.s. in 1940.

3760 I would infer that if the pounds of B.O.D. at Lockport in 1940 were 432,000, equivalent to 27.9 p.p.m., that with 194,000 lb. in 1941, the B.O.D. would be less than half the 27.9 p.p.m. shown in 1940.

3764 I think that the critical thing that is a guess for anybody is the effect of the sludge deposits. With this test coming along, changing those characteristics, I certainly won't make a guess on it.

4015 Mohlman Exhibit 18 consists of the following parts:

18a. Dissolved oxygen and B.O.D. at Lockport; January, 1938 and 1941 (Chart)

18b. Total Discharge at Lockport; January, 1938 to 1941

18c. Dissolved Oxygen and Oxygen Demand at Summit, January, 1938 to 1941

18d. Dissolved Oxygen and Oxygen Demand at Lockport, January, 1938 to 1941.

4000 Mohlman Exhibit 19 consists of a general statement for the assistance of the Court. The first section is 4001 entitled "Sewage Disposal and Stream Pollution" 4009 and the second section "Sludge Disposal".

4464 Mohlman Exhibit 20 is a Table showing the Results of Analyses for Dissolved Oxygen and B.O.D. at Lockport for the Month of January, 1941.

Illinois Exhibit 37A is an extension of Ex. 37, with results brought up through December, 1941.

1496 C. R. ANDREW

Direct Examination by the Master

An aeroplane view of the Brandon Road Pool taken on March 28, 1933, is marked "Andrew Exh. 1."

1497 I am the principal civilian assistant of the District Engineer in the Chicago office of the United States Engineers. Graduated from Norwich University in 1906. Worked on the Ohio River Improvement; then for the Missouri Pacific Railroad for a year; then the McClintic-Marshall Construction Company for six

months. During the War was captain of engineers. Worked for the Division of Waterways. From 1925 to 1930, in private practice; City Engineer for Decatur from 1919 to 1921; with the Mississippi Valley Structural Steel Co. for nearly two years, on construction. Since 1930, have been in the office of the Chicago District Engineer.

1499 Am familiar with the Illinois Waterway. (Identifies Andrew Exh. 1 as correct representation of the Brandon Pool.) The Rock Island Railroad bridge can be readily identified as the first bridge one sees looking
1500 north in that exhibit. Today there is another bridge at McDonough Street.

1501 Sludge in the Brandon Pool and at other points in the channels of the Sanitary District can be removed by hydraulic means. Sludge is defined as material settled out of the water in a deposit so solid that a 10-inch disc attached to a 10-pound lead weight defines the
1502 surface thereof. The District Engineer has made two surveys of the Pool, one in 1933 or 1934, the other in 1939. The deposits since 1933, according to the 1939 survey, have ranged from 2 to 10 feet, and generally
1503 are from 6 to 10 feet. The deposits are mostly below Jefferson Street. Above Jefferson Street there were no appreciable deposits. The depth of the Waterway in the Pool ranges from 10 to 20 feet below the present water surface. The data only indicates the deposit during the period. The material of which I speak can be re-
1504 moved by hydraulic methods. The deposits run from 1,250,000 to 1,500,000 cubic yards. In 1932, the United States removed about 73,000 cubic yards of soft material above Lockport by hydraulic methods at a cost of

not less than 37 cents per cubic yard. The cost of removal would be not less than 40 cents per cubic yard at present, but not including the cost of the spoil area. The total cost would be between $500,000 and $750,000. From six to nine months would be would be required. Navigation would not be disturbed. The material could be placed on vacant land downstream from the Brandon Dam near Hickory Creek, on the
1504 left bank, behind the present retaining wall. About 200,000 to 250,000 square yards would be required for the spoil area, or about 400 acres. I have no idea of the cost of the land, but it is not in cultivation. The dredged material so placed would be left to dry out. There is no other method to remove such material from the Pool.
1506 This deposit has accumulated for years, even with a flow of 8,500 c.f.s. or 5,000 c.f.s. A diversion temporarily increased to 5,000 c.f.s. would not remove such a deposit. In so far as the deposit is the source of odors, a flow of 5,000 c.f.s. will not remove the accumulated deposit. Other means than an increased diversion will
1507 be required. It is physically possible to drain the Brandon Pool by manipulating certain gates in the Lockport lock, the Power House, and in the Brandon Dam and Lock. Such draining will not remove the material of which I speak, in any quantity. Such material can only be removed by dredging hydraulically or otherwise. The United States deposited some 107,000
1508 cubic yards in the Pool from the dredging in the towpath. My estimate of the deposit is within 1,2500,000 and 1,500,000 cubic yards and is not accurate to 100,000 cubic yards. The Government deposit is accurate.

1509 The pollution comes from the flow in the Main Channel. There may be some discharge of oil above the Power House. The most feasible or practical measures to eliminate the odors emanating from the Waterway at Lockport or Joliet are to remove the pollution at its source and to flow an additional diversion. I know
1510 of no other methods which are feasible. I am not a sanitary engineer. I cannot tell whether the odors come from the accumulated deposit or from the current matter coming down.

Cross-Examination by Mr. Clausen.

1510 By sludge, I only refer to the material detected by
1511 the method of sounding used by the District Engineer. I would sink into such material if I stood on it, and could not walk on it. It is detected by a disc 10 inches in diameter attached to a 10-pound lead weight.

I have not considered the biological results of the removal and do not know if material removed would give off odor in the spoil areas. The depth of deposit would be about 6 feet on the spoil areas. Dikes would
1512 be thrown up to create lagoons into which the deposits would be pumped by the hydraulic dredge. The Hickory Creek area adjoins Brandon Pool and is closer to some houses than the wall of the Pool. I cannot tell
1512 how much liquid will have to be pumped per cubic yard of material moved. From 60 to 90 per cent of the material pumped is water.

1513 A cutter head would be required on the suction of the dredge. The cost of the spoil areas and dikes are not in the estimates. The dikes would be built with drag line, with material from within the spoil area.

Cross-Examination by Mr. Naujoks

1513 I served five years with the Division of Waterways
1514 of the State of Illinois. The contract for dredging at 37 cents per cubic yard was on the Waterway, just above the Lockport locks. In the 1940 Budget Report of the Sanitary District, on page 71, the flow of 23 c.f.s. from the Texas Company is water taken from the canal
1515 and discharged into the Des Plaines River or the Creek and eventually enters the Brandon Pool.

The area of land for the spoil areas should be around 40 to 50 acres, not 400 to 500 acres.

Direct Examination by the Master.

1516 There is some deposit in all the pools of the Waterway below the Brandon Pool, above each dam. Such material is not primarily material dropped by polluted water from the Main Channel of the Sanitary District. A great deal of that material is ordinary erosion from the upper end of the pool settling in the lower end, where the current is much less. In Peoria Lake, there is a large amount of very soft material.

1517 A current survey indicates from two to four feet of deposit in the Main Channel from Damen Avenue to Lockport, but not as much as the six to ten feet at the lower end of Brandon Pool.

1518 The Pool was placed in operation in 1932 or 1933 by the United States as part of the Waterway completed under the Rivers and Harbors Act of July 3, 1930.

The Master indicates no need to press the question of opening the locks at Brandon Road with the U. S. Engineer office.

Cross-Examination by Mr. Clausen

1519 In a general way, prior to the creation of the Brandon Pool, the current above the old Jackson Street dam was reasonably slow. Below the dam the river flowed rapidly over rocks in low water. The bottom was very
1520 rough. The channel was from one to three feet deep, depending on the flow from Lockport, but might rise to six or eight feet. The river was not navigable. Navigation went through the old I. & M. Canal.

There is no necessity for removing the deposits in Brandon Pool for purposes of navigation.

Direct Examination by the Master

1521 A new survey would cost from five to six thousand
1622 dollars and might require over two or three weeks, if rushed. There is no way to determine the rate of accumulation at present in the Pool without a new survey. It would be very difficult to obtain accurate quantita-
1523 tive data, because of the type of material. There is still over 20 feet of water in the Pool, so the necessity of dredging is many years away.

Cross-Examination by Mr. Clausen

1523 There is material, semi-liquid or semi-solid, which floats near the bottom of the river over the mate-
1524 rial you define with your disc. I have no knowledge of its amount.

Cross-Examination by Mr. Naujoks

I know of no spoil areas within reasonable distance other than the Hickory Creek area, where dredged material could be deposited by hydraulic means.

Direct Examination by the Master

2031 The movement of traffic on the Waterway and lockages at Brandon Road, for 1938, 1939, and up to March, 1940, is shown by tabulation on page 2032 of the Record.

2033 The structures at the Brandon Road Lock and Dam consist of a section of earth embankment, a lock, and a head gate section. There is an ice chute with a sector dam, also six emergency valves. The dam proper is of concrete, with Taintor gates, which can hold the water 30 inches above the concrete. Of 16 gates, 6 are movable. By manipulating these 6 gates, the water in the Pool can be drawn down to elevation 511, or 28 feet below the present pool water level. If all six gates
2034 were opened, the Pool might be emptied in about three hours, with an average outflow of 13,800 c.f.s., including 2,500 c.f.s. from Lockport. The present capacity of the Pool is around 120,000,000 cubic feet instead of 151,000,000, the original volume. By opening all gates to full extent, the speed of emptying would be too fast and would create a wave downstream, which would
2035 damage low land. By raising only the top half of the six gates, a net outflow of 4,300 c.f.s. would drain the pool in eight hours and lower the water to elevation 521. Elevation 521 is from one to three feet above

present level of firmer sludge, as shown on the 1939 survey.

2036 The level of the Dresden Island Pool might also have to be lowered. The Dresden Island dam is of a different type, consisting of a series of Taintor gates, which can be lifted. The water goes under the gate instead of over the dam. Operation could be conducted
2037 simultaneously with operation at Brandon Road. Because of the wave, further operation would be required at Marseilles and downstream. The ultimate result
2038 transfers downstream considerable material now in Brandon Road Pool into the other pools down river as
2039 far as Peoria Lake. Repeated flushing would lengthen period of time that navigation and other interests are
2041 damaged. Repeat flushings should be done as rapidly as possible. A larger diversion will probably carry more material to the Brandon Road Pool from the channel of the Sanitary District.

Cross-Examination.

2043 I consider the Brandon Road Pool extends from the lower gates of the Lockport Lock to the upper gates of the Brandon Road Lock. The larger proportion of the sludge or even the light flocculent material is located in the lower quarter of the Pool. There is little material in the upper three-quarters above Jefferson Street in Joliet.

2044 As material moves downstream, it would not be uniformly deposited through the channel but would deposit in immediate vicinity of dams or wide portions

of the river where the current was slow. The pools from Marseilles downstream would be in worse condition than now.

Refilling of Brandon Road Pool could be controlled. However, refilling at the rate of 10,000 c.f.s. would set up heavy currents in the Main Channel and would interfere with navigation in the Chicago River and would be hazardous. The level of Dresden Island and all the other dams below would be predicated upon the action at Brandon Road.

Brandon Road Pool does not freeze except in extreme freezing weather. Only on rare occasions does ice form in the Pool or in the Sanitary District channel. Every year there is heavy ice in some parts of the lower river. With ice on the lower river it is hazardous to put extra water through, because of danger of ice gorges and flooding of territory.

Cross-Examination by Mr. Clausen

The whole bottom of the pool can be exposed if necessary. By increasing the flow in the Sanitary District canal, a considerable quantity of the light flocculent material in the canal would be transferred to Brandon Pool. The larger flow or diversion would probably carry more material to the Brandon Road Pool from the channel of the Sanitary District. In filling up Brandon Road Pool at the rate of 10,000 c.f.s., navigation would stop for two or three days in the Joliet Pool and navigation would be interrupted along the river for a greater period.

Cross-Examination by Mr. Naujoks

2057-
2058 A diversion of 5,000 c.f.s. would carry more material than a diversion of 1,500 c.f.s.; that is, as its velocity increases, its carrying capacity increases.

Examination by the Master

2727-
2728 The Government has a permanent force of 25 to 40 men working continuously between Lockport and Brandon Road. There are eight at Lockport, twelve at Brandon Road, and ten to twenty at the moorings and repair yard. Two lock keepers and their families sleep alongside the lock in houses at Lockport, and two lock keepers and families have lived over the bank near the I. & M. Canal at Brandon Road. On a tow boat the crew varies from eight to twelve men, many of whom sleep on the boat. Again, they may sleep at home in Joliet. The crews of non-government craft passing through ran from eight to twenty men. Some boats go through several times a month. Probably 75 to 100 men pass through on commercial boats several times a month.

Examination by the Master

3581 My report on the temporary 10,000 c.f.s. diversion
3582 has to do entirely with operations. No difficulties occurred. We did not get anticipated rise in lower river because of cold weather, which froze the water in the tributaries. Lowering of the dam at Peoria proved
3583 dangerous because of ice conditions. Regarding the

lowering of the Brandon Pool, the War Department will cooperate in lowering it five feet if provision is made to protect water supply of users, the United States to be held harmless of all claims for damage,
3584 and if given ten days' advance notice of any change in water levels. Such a lowering at present will have no substantial beneficial effect unless rising material is removed, while an increased diversion would be helpful, as it dilutes and increases the velocity, but it will not make a substantial difference in the amount of
3585 solids carried through the Pool. A floating boom might be pulled through the Pool on surface to carry floating material raised by lowering the Pool. I doubt
3586 if increased flow will move much of the material now in the Pool. From my records, the effect of the 10,000 c.f.s. test was to wash a large amount of material into the Pool from above. At one place, nine feet of deposit was added, although very little was detected above McDonough Street. Considerable material was washed out of the Pool during the test. Lowering of
3587 the Pool level would not have changed results substantially, even if accomplished at the same time as 10,000 c.f.s. flow, while if Pool is lowered without in-
3588 creasing the flow, no benefit would occur. Only object of lowering the Pool is to free some bottom material to float.

Examination by the Master

3781 Prior to the 10,000 c.f.s. test experiment, we computed the expected velocities in the Brandon Pool with 10,000 c.f.s. and elevation 539, and the average

velocity was 0.47 ft. per second. Current meter measurements on December 5, 1940 with Pool at Elevation 539 and flows from 9,500 c.f.s. to 11,700 c.f.s., averaging 10,500 c.f.s., show average velocity of 0.55 ft. per sec-
3782 ond. Maximum velocity was 1.58 ft. per second at 0.2 depth near center of channel, and minimum measured velocity was 0.07 ft. per second. Actual minimum was zero. The measurements took three hours, and
3784 the location of the measurements are shown on An-
3788 drew Exh. 6. During the 10,000 c.f.s. test, our measurements show the velocity in Dresden Island Pool ran from 1.49 to 2.27 ft. per second, and near the Jack-
3789 son Street Bridge in Joliet, velocities ranged from 1.58 to 3.1 ft. per second, while another series near the Jackson Street Bridge ran from 0.02 to 3.09 ft. per second; and another set from 0.39 to 3.92 ft. per sec-
3789 ond. The velocities through gates at Brandon Dam exceeded 12 ft. per second. No figures are available as to the velocity in the Pool under ordinary conditions prior to the test. The test experiment failed to sweep
3790- out flocculent material because we believed erron-
3791 eously that the flocculent material was light enough to pass through the Pool, even at low velocities. The
3792 effect of increasing the diversion from 1,500 to 5,000 c.f.s. would be to carry material further down the Pool toward Brandon Road Dam. Navigation requires a 9-foot channel and dredging has never been necessary
3793 in the Pool. The depth at which flocculent material is encountered in the Pool depends on the depth. If 20 to 25 feet depth, probably encounter flocculent material at 15 feet below surface. Depths of water are from water surface to point measured by United States

3795 Engineer method of sounding. In my judgment, lowering the Brandon Pool any distance up to five feet in cold weather, or after an extended warm period, with or without additional diversion, would have no appreciable beneficial effect upon the sanitary conditions at
3796 Joliet. Even with a lowering of five feet during recent test, no benefit would have occurred because in the lowering of the Pool five feet, the change in estimated velocities is so small that it would result in only a very small difference in final results of material passing out
3797 of the Pool. No complaints of damage yet received from this 10,000 c.f.s. experimental flow test. I have worked fifteen years along the Waterway, except for
3798 six months. In 1924-1925, I was located at Starved Rock. Odors from the river were very offensive. Odors from the Marseilles Dam also were very offensive. Odors in Joliet were very offensive. Conditions improved until 1930. In 1933, when dams went into operation, water continued to improve. From 1933 to 1938, conditions improved year by year, with nuisance only where water was broken up at Lockport or Brandon Road dam. Unable to make comparison between
3799 1925 and 1939 because conditions were so different.
3800 Opinion is conditions were about the same. Prior to 1935, odors at Joliet were not obnoxious. My recollec-
3801 tion of conditions at Joliet falls into several periods: (a) 1925 and shortly thereafter—conditions very bad; (b) 1933 to 1938, conditions were improving; (c) 1938 was best; (d) 1939 was worst; and (e) 1940 not as bad as 1939. Odors not particularly noticeable below Dresden Island.

3801 The number of men in the employ of the War Department at Joliet varies from 65 to 70 at the various locks, and at the moorings, 25 to 30 more. The crew is quartered in only one boat; six to eight men. No par-
3802 ticular increase in complaints of illness in 1939 from those men.

Examination by Mr. Cohan.

3802 The velocity in the Pool is 0.47 ft. per second, with 10,000 c.f.s. flow and elevation 539, normal elevation, and 0.63 ft. per second with 10,000 c.f.s. flow and ele-
3803 vation 534. If Pool elevation were lowered more than
3804 5 feet, the velocity would be greater. With equal flows, the velocity in the Main Channel regular section will always be greater than the velocity at any point in the Pool below McDonough Street. I re-
3806 moved some material from the Main Channel by hydraulic dredging. We called it silt and sludge but no chemical or physical analysis was made of the ma-
3808 terial. Water leaving Pool through gates passes under
3809 ice protection wall. Impracticable to lower pool 1-1/2 feet by lock gates. Generally speaking, I would say the
3810 area of Dresden Pool is much larger than Brandon Pool; at least twice; maybe three or four times as large.

Examination by the Master.

3810 I am more and more of the opinion that it is not feasible to drain out the Pool entirely by opening gates and locks. Other methods can be used to remove material, namely, hydraulic dredging.

Examination by Mr. Clausen.

3811 I do not see all the sick leaves for all field employees. Government physician at Joliet only treats injuries. I know of no skin diseases reported in 1939. Government physician only reports in connection with accidents.

Examination by the Master.

3817 In connection with the experiment, I felt it hazardous with 10,000 c.f.s. flow if it occurred when large amounts of ice were in the river and if the Pool were drained by opening all gates at once, as it might damage and overflow land below Brandon Dam. Actually, we had no ice above Starved Rock, but the ice in Peoria Lake went down and endangered operation.

Examination by Mr. Cohan.

3819 The Illinois Waterway has eight pools and it is almost impossible to drain all pools to be empty.
3820 Dredging of Brandon Pool is preferable rather than
3821 trying to empty Pool. If the material now in the Pool were put in the River below Brandon Pool, someone would have to remove it from navigation channels.

2608 C. K. CALVERT

Direct Examination by Mr. Clausen

2609 I have a B.S. degree from Earlham College. While in College, I was a Chemist with the U.S. Geological Survey for 6 or 8 months.

I served as Chemist for the Indianapolis Water Co. from 1908 to 1921. From 1921 to 1936, I was engaged on sewage treatment work at Indianapolis, first on the operation of the experimental plant, then on the construction of the final plant, and finally as Superintendent. During four of those years I was Superintendent of the Indianapolis garbage plant, acting as Superintendent of the Plant for a number of years.

From 1936 to date employed as Superintendent of Purification of the Indianapolis Water Company.

2610 I am a member of various technical societies and have held office therein.

I have had occasion to utilize chlorine in water works at Indianapolis about 1910, first as calcium hypochlorite and then in 1916 as liquid chlorine.

2611 Chlorine was used at the Sewage Treatment Works of the Indianapolis Sanitary District in 1930, at first in the laboratory to learn the effect of chlorine on plant effluent for control of river conditions.

Later used from 3,000 to 6,000 lb. per day on a plant scale in an attempt to control river conditions below the plant. In my water work now I am using from 1000 to 6000 pounds of chlorine per day according to the season and the condition of the water.

In a test on the White River, during August, 1930, a sewage flow of 79 c.f.s., mostly activated sludge plant effluent entered a river flow of 162 c.f.s. which contained about 4.1 parts per million of dissolved oxygen, or about 7600 pounds per day of oxygen.

2612 The effluent contained about 36,800 lb. B.O.D. per day. In the pool below the sewage outflow there was a B.O.D. of 35 parts per million. The stream con-

sisted of a series of pools and riffles. Above the plant stream contained 4.1 parts per million of oxygen. The flow below the plant was about 242 c.f.s. The pools varied in length from 200 yards to a mile. In the riffles the river water picks up oxygen and gives off the noxious odors from decomposition in the pool above. During the summer 150,000 lb. of Chlorine were used.

2613 The chlorine was applied by a home-made apparatus, by delivering the liquid chlorine into a stream of water under high pressure and high velocity. The chlorine entered the sewage in solution. An average of 10 parts per million of chlorine was applied, more than enough to satisfy the 10 minute demand. The rate was changed during the day on the basis of chlorine demand determination in the laboratory. A residual chlorine averaging around 3½ parts per million entered the stream, but sometimes as high as 7 parts per million. I tried to put in enough chlorine to show some free chlorine downstream.

2614 The residual chlorine is the chlorine remaining in the mixture as it entered the stream, which could be removed by the titration of the chlorine by sodium thiosulphate in acid potassium iodide solution. We set up a residual to carry free chlorine down stream as far as we could to take care of the reducing substances produced in the decomposition of the sludge in the pools below the sewage outfall. The residual chlorine usually disappeared as soon as the sewage flow entered the river, in a distance about 2,000 feet. On one occasion residual chlorine was found about 0.7 mile below the outfall or about 2 hours flow.

2615 The reduction in B.O.D. of the plant effluent was about 10 per cent or 20 parts per million or about 2 parts per million of B.O.D. per part per million of chlorine added. In the laboratory, prior to plant scale operation, a reduction of B.O.D. was found about 35 per cent, but this did not occur in practice. So far as the determination of B.O.D. is concerned, the reduction was permanent for the duration of the test, i. e. 5 days. But when it goes into the stream, no difference could be found in the stream, maybe because it is so small. The reduction in the field was much less than in the laboratory experiments.

Primarily chlorine acts as a sterilizing agent. Chlorine is toxic to bacteria. Chlorine also unites with certain forms of organic matter, in reactions which are not well understood.

2616 The application of chlorine reduces the number of bacteria enormously. Some forms of reduced substances are attacked. Chlorine may combine with amines or ammonia, so both are destroyed. After the chlorine is gone, the bacteria remaining are low in number, but there is plenty of food. If the temperature is right, the bacteria then increases rapidly. In relatively pure water bacteria may multiply 100 fold in six hours. After the chlorine residual disappears, the bacteria freely grow again, and multiply very rapidly.

2617 In relatively pure water, chlorination produces low counts. In 6 hours flow in a settling basin, the count may increase a hundred fold. The phenomena may be described as delayed decomposition, since decomposition can take place only through the action of bacteria.

Chlorine is not a substitute for Chemical Treatment or Activated Sludge treatment in permanently reducing B.O.D. Chlorine is not a suitable agent for treating sewage adequately. If enough chlorine can be added, to produce a permanent residual of real chlorine, decomposition would be delayed permanently. A high degree of chlorine may be equivalent to pickling, rather than purification.

2618 In an attempt to obtain a real chlorine residual on an activated sludge plant effluent containing 7 parts per million of ammonia, 175 parts per million of chlorine was applied before a real residual was obtained. That is certainly a pickling agent.

Chlorine is usually applied by putting the gas into solution and carrying the solution to the liquid to be treated. Mixing must be thorough and quick.

2619 Dry application is not satisfactory, because it is difficult to keep the diffusers clear, and difficult to secure proper dispersion. Chlorine is bought in 100 lb. cylinders and 15 ton tank cars. Ton containers are delivered by truck at the Indianapolis water plant. Chlorine is first volatilized in heaters and then delivered into chlorinators, which put the gas into solution. The solution is piped to the point of application. The chlorinators and the pipe require corrosion-proof material. Wet chlorine is very corrosive. Precautions are necessary to protect the men working with Chlorine,
2621 particularly to secure tight joint on all piping. Fan ventilation is provided for quickly changing the air or gas in the rooms housing the chlorinators, evaporators and consumers. The exhausted gas should pass through a spray of cold water or caustic soda solution to pick

up the chlorine gas before discharge to the atmosphere. Gas masks should be available.

I am familiar with the conditions along the Main Channel and at Joliet from past visits and a recent
2622 trip with Dr. Mohlman on September 18. The temperature in Chicago was minimum 61, maximum 78, with south to southwest wind, 13 miles per hour. I noted no precipitation. I have seen the operating records of the District plants in this case. I have learned of the sludge deposits in the Main Channel and Brandon Pool and have seen the gas rising from the deposits. To my mind to remedy the conditions in the Main Channel and the Joliet Pool the most important change is to keep the sludge out.

2623 Sludge settles in a slowly moving stream, forms banks, decomposes anaerobically and uses up oxygen very rapidly in the supernatent water. I do not know the 5-day B.O.D. of sludge. Routine tests for it were never run at the Indianapolis sewage treatment plant. Special tests were unsuccessful. The 5-day B.O.D. is only a small part of the B.O.D. which may run for hundreds of days. I know of no sewage works in the United States which makes 5-day B.O.D. determinations on sludge as a routine. It is sometimes done in research work.

2624 For immediate action to better conditions in the Main Channel and Joliet Pool, an increase in diversion is most effective, because it introduces fresh water and dilutes the organic matter and provides conditions for the normal biology of the water biology to proceed.

Chlorine is not advisable for the betterment of the Main Channel and Joliet Pool. The experience at

Indianapolis was unsatisfactory. No sludge as such went into the stream, only a mixture of activated sludge effluent with a little clarified sewage. This mixture enters the stream in a pool. Sludge banks form in the pools below the plant. The pools are around 4 to 5 feet deep, sometimes 10 feet, but are interspersed with riffles where reaeration occurs and objectionable gases are eliminated. In the first six miles of flow the water
2625 is passing over riffles nearly 50 per cent of the time, yet at this 6-mile point, about 18 hours away from the plant, conditions were not satisfactory either with or without chlorine. In the case of the Main Channel at Chicago the depth, 25 feet, is much greater than in the pools at Indianapolis. There is little chance for reaeration, the flow is slow, and sludge deposits are in the Channel. This is true of the Brandon Pool as well as the Channel. If we were unable to correct the conditions at Indianapolis where we had more favorable conditions than exist at Chicago, then I cannot expect to correct the Chicago condition by the use of chlorine. At Indianapolis the residual chlorine was found on only one condition farther away from the plant than about 2,000 feet. On that basis application would be needed every half mile. Without rather extensive laboratory determination and study of the conditions themselves, I would be afraid to guess.

2626 The operating expense is considerable for applying chlorine. The building requires janitor service, perhaps a laborer would be required. Electric lights and telephone are needed. Fuel is needed for vaporizers and heating building. A Chemist should be on duty at all times, also someone of better than average ability

should be available for chlorinator repair and adjustment, also to connect new containers to the chlorine lines as the containers are emptied.

2627 Suitable housing must be supplied. A switch track is also required. Apparatus deteriorates rapidly if not used. Chlorinators may last 5 years.

Piping may not last as long. If moved, the lining may crack.

Chlorine Treatment for the Chicago Joliet situation would require a chlorine application of 150 tons per day as a moderate estimate. The application is required over 5 or 6 months, because the temperature is 15 deg. Cent. or higher for 5 or 6 months.

2628 The expenditure of money for Chlorine in an amount of 150 tons per day to dose the canal is not justified on the basis of the Indianapolis experience. I cannot believe the nuisance would be reduced in a measurable amount in the Joliet Pool. We could not find it at Indianapolis. There is a similarity of industrial conditions at Chicago and Indianapolis. The wastes are preponderantly organic. Both places have slaughter houses, canning plants, laundry and dairy wastes. At Indianapolis there is little iron waste.

2629 Knows of no Chlorine Plant in U.S. designed to and using 50 tons Chlorine per day.

It is difficult for the Indianapolis Water Co. to obtain delivery on Chlorinators at Indianapolis. No delivery is promised at this time on recent orders. We hope for delivery next Spring, because our new plant goes into service then. The Company furnishing the Chlorinators is making war material which takes precedence over chlorinators for other purposes.

2630 The effect on Brandon Pool by passing the water over a dam or cascades at Lockport would improve conditions very slightly. It would set free many noxious gases and pick up a little oxygen which would quickly disappear. At Indainapolis after 1930 a dam was built in the White River below our plant. Some oxygen was picked up, but not a great deal, perhaps a few tenths or one or one and one-half parts. Within a quarter or half a mile below, with a B.O.D. around 10, the oxygen so picked up was gone. Yet the river was in the nature of a riffle below the dam and shallow .

Cascades would create a local nuisance.

2631 At Lockport, wherever a septic sewage or liquid high in B.O.D. and devoid of oxygen passes over an aerating device the gases leave the liquid and go into the atmosphere.

2632 Indianapolis has a population around 385,000. The water purification plant has a maximum capacity of 51 m.g.d. but produces an average of 30 m.g.d. with a maximum of 45 m.g.d. The capacity of the Sewage Treatment Plant at Indianapolis is rated at 55 million gallons per day. Some of the water used in Indianapolis comes from wells.

2633 The sewage works is an Activated Sludge plant, preceded by clarification. It started in operation on clarification in 1924. I was with the plant then. The activated sludge process began in May, 1925. Not all the sewage was treated by activated sludge, until the summer of 1936. It was our practice to operate the activated sludge plant to a higher rate in summer, than in the other months, because the flow in the river was lower in the summer.

2634 We treated more million gallons in the summer. We were using from 1,000 to 6,000 pounds of chlorine daily in the water plant.

Cross-examination by Mr. Naujoks

3161 Conditions in Chicago are more difficult for application of chlorine than in Indianapolis, because of the
3162 greater depth of the Channel, the discharge of sludge into the Channel and the more extensive sludge deposits. The B.O.D. of the water in the Channel is higher at Chicago. The amount of B.O.D. per cubic foot second of water is about the same. The B.O.D. of the water to which chlorine was applied at Indianapolis was about 8 times greater than that in Brnadon Pool. The B.O.D. of the raw sewage at Indianapolis is about 3 times as great as that at Chicago. The suspended solids are several times greater at Indianapolis. Indianapolis has
3163 a stronger sewage in general than Chicago. Indianapolis is fully metered and water is used more carefully, running about 80 gallons per capita daily as compared to 250 or 300 gallons in Chicago, of which I am not quite sure.

3164 At Indianapolis the chlorine is gone in about 2000 feet, and if that is taken as evidence, I would say it should be applied every 2,000 feet. I qualified that by saying considerable experimental work is required to know how often it should be applied, where and how. This is based on my experience at Indianapolis where chlorine quickly disappeared. Construction of aerating

cascades in the outfall sewers of the Sanitary District is not a mistake.

The White River at Indianapolis carried only 4.1 parts per million of dissolved oxygen. This indicates the presence of organic matter and the depletion of oxygen. That river had much less oxygen than that with no sewage added to it for 40 miles. The river has been polluted but had recovered, through its biologic cycle, growth and development of algae and their death, which consumes oxygen.

3165 The oxygen may be low, and still not be a polluted stream under some conditions. At time of test the B.O.D. was 6 and dissolved oxygen 4.1 p.p.m. The test was made to determine if chlorine would improve conditions until the plant could be enlarged to take care of all the sewage. Before the test was made, my opinion was that the better procedure would be to enlarge the plant. The tests at Indianapolis were not made with standard chlorine feeding devices. This was unique in the United States.

3166 The handling of chlorine as we did it was not new in its basic principles. Chlorine at Indianapolis was not applied to reduce odors from hydrogen sulphide. No particular observations were made at Indianapolis on the delayed action effect of chlorine. Nor were we interestered in relative efficiency of chlorine and activated sludge treatment in the removal of B.O.D. The Indianapolis plant was too small. Money was lacking to build
3167 a larger plant, and time would be required. In 1929 when the use of chlorine to protect streams came along we thought there might be a chance to improve conditions until the plant could be enlarged. The stream was

in bad shape. No systematic observations of hydrogen sulphide were made or the effect of chlorine, if any, on it. We applied chlorine directly to the sewage effluent before it entered the river. It was much easier. Application in the stream would have needed elaborate mixing devices.

3168 Bottle experiments in a laboratory are difficult to translate into actual conditions in a stream or on a plant. To say that the reduction of B.O.D. by chlorination or any other means as shown by the 5-day test, is not a permanent reduction for 5 days, is an acknowledgment that the 5-day test is no good. If a portion of sewage with its oxygen is put in a bottle and held for 5 days we say the oxygen used in that period is its B.O.D. If another sample treated by some chemical or biological process is subjected to the same procedure in another bottle, we say the difference between them

3169 is permanent for five days and is due to that treatment. I cannot say that if a certain reduction of B.O.D is found in the laboratory that treating a similar liquid in a similar fashion and putting it in a stream will result in the same thing. As a matter of fact I do not think it would.

3170 If you make the determination of B.O.D. in the canal before treatment and after treatment, whatever difference occurred is due to the treatment. You have to repeat the tests many times to be rid of irregularities. It is what we did at Indianapolis after we did our bottle experiments. The normal way is to do some

3171 laboratory work first and then try to apply a suitable factor of safety. The normal way to determine the good done by chlorination is to take the B.O.D. before and

after chlorination. To determine how long the effect
3172 of chlorine lasts, tests should be made of the waterway at stated intervals. The B.O.D. tests only give the B.O.D. at the time the tests are made. I do not understand what is meant by permanent in this connection.

3173 The B.O.D. test is made in a bottle, not in the open in a waterway. The B.O.D. test on a chlorinated sample is permanent for the 5 days in the bottle. This does not mean that 5 days below the point where the sample was taken, the B.O.D. reduction is permanent or that the same B.O.D. is obtained. Conditions may change, even at the point where the sample was taken
3173 five days later or ten days later. If the stream was
3174 bottled up so the condition was the same five days or a week later, then the B.O.D. would be the same. Unless the stream were bottled up, the sample taken today might not be representative of the situation two weeks later or at the same point. I am not sure that a 10 p.p.m. reduction in B.O.D. could be made permanent for 5 days in the river, with a residual chlorine at all times. It might be, but this is doubtful. You can hardly find 10 p.p.m. in a large quantity of B.O.D. The determination is not that accurate.

3175 Indianapolis has lagooned its activated sludge without digestion or any treatment for a period of 15 years or more, and still does, even with a materially enlarged plant.

A lagoon is an earthen storage basin into which sludge may be pumped.

Material in a lagoon digests but most lagoons are so deep that effective drying is slow and takes a period of
3176 years. The description is simple, but the operation is

more complicated. It is really digestion in deep pits. The fresh sludge is composed of mixed primary and activated sludge, placed in a part of the lagoon in which there is active and sweet digestion so the seeding is good. If it is all added at one point continuously sour digestion develops, with offensive odors and inefficient digestion. In draining and handling the pits, care must be used to have the sludge as dry as possible before removal.

The lagoons are about 10 or 11 feet deep and 300 feet square. They cover about 40 acres at Indianapolis
3177 for some 50 to 55 m.g.d. of sewage. The 1940 population is about 385,000. The lagoons give off some odor. They are isolated. No habitations are near, but there are some slaughter houses and fertilizer works. There is no appreciable amount of hydrogen sulfide gas given off. There is a dominant odor of sweet digestion of
3178 sludge, not the acid digestion. To a sewage plant operator, this odor indicates good biological action. It might be offensive to ordinary persons. The health of workers around lagoons is not affected. In connection with the experimental work at Indianapolis, I recall discussing chlorination with Enslow many times. I do not recall any objection from Enslow. I believe he aided
3179 and abetted. If he had put a damper on it I do not think we should have tried it, because we valued his advice. There was no use in the experiment if good results could not be expected. The matter was discussed before the work started. Chlorinating the water before cascading would reduce somewhat the release of odors.
3180 Any odor which is caused by a material which will combine with chlorine to form an unobjectionable sub-

stance would be eliminated. The time during which the dissolved oxygen introduced at the cascades remains effective would only be extended in so far as the amount of chlorine added was effective in itself.

The present conditions in the Brandon Road Pool result from a deficiency in oxygen, in a measure.
3180 When the flow was higher and the B.O.D. in total
3181- poundage per day was higher, the conditions in the
3182 Brandon Road Pool were not objectionable then. Actual experience is much better than any opinion I might have or any handling of figures of B.O.D. and D.O.

3183 A given amount of dissolved oxygen is not efficient in ameliorating conditions resulting from sewage pollu-
3184 tion, regardless of its source. Dissolved atmospheric oxygen is effective, in sufficient quantity. Available oxygen from chemical sources is not dissolved oxygen. Chlorine in solution in water is HOCL, and theoretically the "O" is available. Assuming 150,000 pounds of dissolved oxygen from the lake water in 3,500 c.f.s. and assuming 150,000 pounds of dissolved oxygen from the aeration of sewage, immediate B.O.D. would be taken
3185 up by either one as quickly as the other. But each might not be equally effective in removing the ultimate or the 5-day B.O.D. The 5-day B.O.D. would be less in the case of dilution than by adding air by blowing through.

3186 In dilution, the biologic balance is different. The conditions are changed with different amounts of organic matter. It is easier to remove a dilute B.O.D. by aeration than a concentrated B.O.D. The immediate B.O.D. is caused by reduced substances such as H2S,

which immediately unite with oxygen without intervention of bacteria or any waiting period. Permanent B.O.D. is a B.O.D. which will not reappear under the influence of biologic action, bacterial or biologic growth.

3187 I can remove 10 parts per million B.O.D. more quickly from a sewage with 35 p.p.m. than from one with 15 p.p.m. The fact that Cleveland, Ohio practices seasonal chlorination during the summer only does not change my opinion that chlorinators need overhauling completely if idle for a time. New parts may have to be supplied, as required.

3188 I do not know that practically every water works has duplicate chlorinating equipment, half of which is idle all the time and yet is ready for instant use. There may be improvements of which I have no knowledge. The Indianapolis Water Company does not have a number of chlorinators in reserve, idle practically all the

3189 time. It has no equipment not in use. It has equipment which is idle part of the time. Any properly operated plant rotates machines and sees they are all in service on a given schedule, ready to use at any time. No piece of machinery at Indianapolis is permanently idle. Throughout the year there is a certain percentage of all machines which are not in use.

3190 If machines are allowed to stand idle and are wanted suddenly, they may not be serviceable. If you have 10 work horses and are only using 3 or 4, you do not let them stand idle in the barn. We have duplicate machines for every use, but they are not machines standing idle waiting for a time when needed. It is not difficult to expand a 25-ton chlorine plant to a 50-ton

plant. It is simply a matter of building a larger plant in either case.

3191 I do not recall whether I ordered the chlorine at Indianapolis for the test and decided to go ahead before talking to Enslow.

Examination by the Master

3192 As a matter of plain reasoning, it is difficult to say there is more chance of hydrogen sulfide in the Brandon Pool than in the digestion pits at Indianapolis. There is considerable odor of other sorts about the plants. A small amount of hydrogen sulfide may not be noticeable. In the use of sludge gas for power in some plants, hydrogen sulfide is removed. If there is hydrogen sulfide in controlled digestion, there must be some in our pits. Tests were not made, but hydrogen sulfide is not a dominant odor about the pits.

3193 There has been no illness from hydrogen sulfide at the Indianapolis sewage works so far as we know.

Cross-Examination by Mr. Naujoks

At Brandon Road Pool, hydrogen sulfide may come from both water and sludge if under anaerobic conditions. Sludge is a concentrated organic matter which under biologic or bacterial action yields hydrogen sulfide. A dilute solution of similar organic matter might
3195 also produce hydrogen sulfide. There is nothing in a combination of sludge and water which produces more hydrogen sulfide than sludge in lagoon, unless there is

a chemical action on the gases passing through a strong solution. The water from Lake Michigan contains dissolved oxygen which should be a factor against these gases. Maybe the plant in Indianapolis should pro-
3196 duce more hydrogen sulfide than the Waterway, even with the reduced flow. The water in the Pool is anaerobic, due to the sewage and sludge. The hydrogen sulfide produced there is in an amount in the same relationship as the organic matter present. We are justified in assuming that there should be as much hydrogen sulfide from the digestion pits as from a similar volume of canal water and sludge. There is a relative difference in organic matter.

It is difficult to say whether most of the hydrogen sulfide comes from the solids at the bottom of the Pool or from the dissolved sulphates in the water.

3197 There are more sulphates in the Indianapolis water than in Lake Michigan.

The oxygen combined with hydrogen in water is not available for the use of B.O.D.

Redirect Examination by Mr. Clausen

3198 Water works as a rule have more equipment than necessary to do the immediate amount of work. In a large installation, some additional equipment is required. For chlorination equipment, perhaps some 50 per cent additional is required. The amount depends on the size of the installation. For work here, 50 per cent would probably be satisfactory. Chlorine was not
3198- applied to raw sewage at Indianapolis, but for

3199 the most part to the activated sludge effluent and the balance to the settled sewage. Indianapolis has considerable industrial waste, maybe more in proportion
3200 to its population than Chicago. The use of home-made equipment in the Indianapolis experiments had no bearing on results. The equipment was satisfactory for the tests. Any hydrogen sulfide in the Indianapolis situation would have united with the chlorine promptly. At Indianapolis, the B.O.D. is determined before and after the application of chlorine.

3201 The laboratory experiments indicated an expected reduction of 30 or 35 per cent of the B.O.D. Actually in practice we obtained about 10 per cent.

The time of flow through Brandon Pool is around 19 to 24 hours. In that time only one day or less of the B.O.D. is used against the oxygen in the lake water. Dilution water supplies dissolved oxygen, and also
3202 dilution. That is not done by aeration. Dilution improves conditions by favoring growth of more different kinds of life. It dilutes organic matter and reduces odor and reduces time of flow in the channel, as well as supplying dissolved oxygen. From the experience at Indianapolis, chlorine to be effective must be sufficient to exert a pickling effect. This prevents growth of bacteria and pushes organic matter downstream. It is oxygen of an entirely different sort, entirely unsuited for the use of life.

3203 The use of cascades of aeration is a step in the right direction. Aeration over the dam at Indianapolis with a small fall, 48 or 54 inches, picked up oxygen in a stream containing from 10 to 15 p.p.m. of B.O.D. but the oxygen was quickly used up in a few hours flow. It

was used up immediately. The mixture of river water and effluent carried about 10 p.p.m. of organic matter.

3203-3204 The cost of nitrates is considerable and the effectiveness is doubtful. In an activated sludge plant, a longer time is required. Nitrate oxygen is only available after dissolved oxygen is gone. During time the nitrate oxygen is used, odors may occur. From an effluent high in nitrates, trouble may come from excessive algae growths.

Examination by the Master

3204-3205 The same test methods were applied to the laboratory scale experiments and the plant scale operations.

Recross Examination by Mr. Naujoks

3205 I do not know what is the principal source of hydrogen sulfide in sewage treatment plants. I would not try to choose a principal source. It would depend on the amount of sulfates and the kind of sulphur in the sludge. I am not competent to answer.

ANTON JULIUS CARLSON

Direct Examination by Mr. Wallenstein

2873 I have received a Bachelor's Degree and Master's Degree from Augustana College in 1898 and 1899. I received a degree of Ph.D. in Physiology from Stanford University in 1903. I received a degree of M.D. from the University of Lund in 1917 and I have the honorary

degrees of Doctor of Science and Doctor of Laws from Appleton College, Augustana College and the University of Colorado.

I was Assistant in Physiology at Stanford University Research Associate of Carnegie Institution of Wash-
2874 ington, Instructor in Physiology in the University of Pennsylvania Medical School and since 1904 I have been on the medical faculties of the University of Chicago, Rush Medical College and the Medical School of the Division of Biological Sciences. For the last 25 years I have been Professor and Chairman of the Department of Physiology in the University of Chicago and for the past 10 years have been the Chairman and Frank P. Hixon Distinguished Professor of Physiology in the University of Chicago.

2875 I belong to numerous societies and associations.

2876 I am familiar with the Sanitary District Canal, the Illinois Waterway and the so-called Brandon Road Pool
2877 at Joliet. In June 1939, I passed by the pool and noticed a sewage odor. I made an inspection trip on the Illinois Waterway and Brandon Pool on the afternoon of October 13, 1940, from three to five.

2878 I read all of the testimony of the local physicians and most of the other. I read the testimony of Thomas Testin.

2880 An actual menace to health to me means that conditions exist in that pool that through accidents or any ordinary course of human events in the district can lead
2882 to health injury. It is my opinion that the concentration of gases and other odorous particles in the air emanating from that pool adversely affect the health of the people subjected to that kind of odors and that concen-

tration of odors. Hydrogen sulphide gas is a highly poisonous gas to the human and animal organisms. It
2883 is about three times as poisonous as carbon monoxide, but not quite as poisonous as the deadliest of all known gases, cyanide. It is an irritant gas. It affects the delicate membranes of the eye, the nose and throat. The
2884 human system can be tremendously injured before we are sick.

2887 The odors of putrefaction and hydrogen sulphide that I observed both in the summer of 1939 and yesterday, are more than a menace, because a menace is something that may occur but hasn't. Hydrogen sulphide is a heavy gas and that will roll over the retaining wall and concentrate down on the homes of the people who live lower than that water level, unless the wind is very
2888 strong. We don't know at what dilution it ceases to be a menace. Putrefaction odors have their effect on the human system. They will affect the heart; they will affect the circulation. It may produce headache, produce salivation, nausea, lack of appetite. Hydrogen sul-
2889 phide and the other odors do set up these direct irritations and these secondary sequences in the nervous system which produce these effects. The present condition down there, certainly as I saw it in the summer of 1939, is more than a menace to health; it is inimical to health. There inevitably will be a menace from dysentery bacillus, from typhoid bacillus and from the amoeba of dysentery, and the water doesn't have to be used for drinking or cooking to constitute such a menace, and it doesn't have to occur either for 10 or 15 or
2890 5 years. It is still a menace. This highly polluted body of water may through accident, through flies or mos-

quitoes, or spray or wind get on the surface of man, on his clothes, on his skin, or in his food, or even in his drinking water, even in his lunch pail, and anything—we know anything that gets on our skin anywhere—flies don't have to bite, mosquitoes don't have to bite, they don't have to settle on the water. This stuff splashes up on the sides when the boats go through, when they empty their locks and fill them and when the wind blows. Such a polluted, highly infectious body of
2891 water of that extent is an actual menace. The fact that the present communicable disease rate in the City of Joliet is no higher than other cities in the State of Illinois would not be a factor in determining whether or not the Illinois Sanitary District Canal in its present condition is an actual menace to the health of the community. They have either been lucky or the medical statistics isn't what it is supposed to be. Germs could reach the community in various ways. The water is
2892 not used for bathing, but people will drop in by accident and the children will jump in by choice, no matter what you say. It can reach them that way. The bacteria can reach them from flies and mosquitoes carrying this stuff mechanically from where they have lit on the walls of the canal. Under extreme conditions it might reach them if they walk close by the canal by spray in a high wind.

When I observed hydrogen sulphide gas in the air I salivated considerably. There was more secretion of tears and after a while I had a peculiar sensation or taste in the back of my mouth. Where the concentration
2893 is not heavy, the physiological reaction of the human organisms is largely reflex through the nervous system

as a result of our social conditioning. As a result of that setting in the nervous system, these substances, these odors, acting on our system, and that will vary with individuals—some have a keen nose, as we say, some don't smell so well, so that will vary with the individual. They set up these processes of the salivation, a disagreeable state, inability or lack of desire to eat when those things are present. Some individuals develop headache. In some individuals we can show that this setting inhibits gastric motility and gastric secretions, and in others
2894 produce vomiting. Human being are very variable, but those are the general things that do happen.

Hydrogen sulphide is heavier than air. It is more
2895 noticeable during the moist weather. It affects different people in markedly different ways. The olfactory senses become quickly fatigued to the smell of hydrogen sulphide, but it also quickyl recovers.

Examination by the Master

2897 I am familiar with the fact that there has been untreated sewage put into this Waterway for many years.
2898 I would consider it undesirable. Under certain conditions I would consider it a menace to health. The pool has been in existence three or four years. The menace has been less while the flow was greater. You increase the menace by concentration, reduced speed
2899 of flow, and diminution in oxygen. I would say that there was some menace there before the flow was decreased. The gradual efficient handling of the sewage reduces the menace. I know nothing about con-

2900 ditions in the summer of 1940. There is plenty of menace today. I could not compare the menace today with the menace in 1939. There has always been a menace since this pool existed. It has increased with the cut down of the flow. A fact on the other side is the improvement in the sewage. Notwithstanding the im-
2901 provement there is a greater menace today because of the cutting down of the water. The actual menace would be largely from the infectious organisms in the water and from the hydrogen sulphile. Infectious organisms in the water would be translated by splashing, by people going in, by flies and other insects getting these organisms on their legs and then getting to human being. I do not place any weight on that at present.

2902 Any open waterway under modern conditions of life would not be safe for drinking without treatment, without filtration or chlorination. Lake Michigan water near the shore is not safe to be used for drinking with-
2903 out treatment. I am more worried about the menace from the standpoint of people falling in or children going in than the likelihood of drinking. If flies carried
2904 the organism to human food it would cause dysentery, amoebiasis. The odors are not a menace; they are actual injury. Hydrogen sulphide is a protoplasmic poison, and so are many of the other substances that we get into our system in our development of civilization. That is one of the very serious poisons, protoplasmic poisons, which in certain concentrations produce symtoms that we can see, but we can be terrifically injured before we reach the point that the doctor can say we are sick or we feel sick. That is the problem before us.

ANTON JULIUS CARLSON

Cross Examination By Mr. Naujoks

2971 I have never practiced medicine privately, but I have trained some over 5,000 doctors.

Bubbly Creek, the Canal or part of the ancient 2972 Chicago River back of the stock yards, possibly had no flow of water from Lake Michigan in the sense of our intake now; but, of course, if there was any flow at all, the water did come from Lake Michigan indirectly through the sewage system and the water system of 2973 Chicago. The rain water, of course, surface water goes in.

I have never made any analyses of the water in the Brandon Road Pool. I have never made any chemical analysis of the air above or in the vicinity of the 2974 Brandon Road Pool. I have not made any analysis of any scum on the face of the water at Brandon Road Pool, nor any analysis of the water which flows from the oil refineries into the Illinois Waterway below the Lockport lock.

2975 Carbon monoxide is a poisonous gas and in enclosed areas can be fatal to an individual. Carbon monoxide unites with the hemoglobin, the red pigment of our red blood cells and anything that interferes with the 2976 union of oxygen with a red cell is detrimental. Of course, in cities, a certain amount of carbon monoxide comes from other sources besides the automobile sources. It is not a menace because menace is some- 2977 thing that is threatening but not actually doing. It is unfavorable because it interferes with the union of oxygen with the red pigment in our red blood cells.

2978 I have not weighed the comparison that carbon monoxide from automobiles in the City of Chicago is just as objectionable from a health standpoint as the odors from this Canal, and a menace, as I understand it, is something threatening, and, if it does happen, would injure, but it hasn't actually done so.

I am interested in ameliorating any conditions which are, or remedying any conditions which are, harmful to 2979 the human machinery. My research is directed towards understanding the human and animal body workings in health and disease, and the matter of health has become and is become a very large concern of medicine, physicians and biological investigators.

I am not familiar with any evidence of direct injury of mercaptan in comparison to such substances as sulphur dioxide; but if mercaptan is present in concentration and through its action on the olfactory system introduces the same unfavorable conditions as the emanations from the Brandon Pool, I should say it was in a similar way unfavorable or injurious to health.

ANTON JULIUS CARLSON

Examination by the Master

2980 If the Supreme Court restored the flow to 5,000 c.f.s., there would still be a menace to health, but it would be less. It is a matter of experiment, and I should think the Court and the States should be ready to make the experiment. We can predict to a certain extent what will happen, but if they actually restored this flow for one season we could follow the bacteria, we could

follow the oxygen, we could follow the odor; then we would know, if the Court please, and we would'nt be quibbling. There would still be a menace in the bacterial contamination. There would be, in my judgment, very great reduction in sulphur dioxide and in the other odors because of the increased oxygen and the increased flow.

2981 If the odors are due to gases other than sulphur dioxide, that is sulphur hydrogen, the health of the people working in a sewerage plant, if the odors produce these symptoms in them, their health is unfavorably affected. One must have a tremendous amount of injury before one is incapacitated for work, but there would still be a menace to health even though one did not receive that amount of injury.

2982 I am not testifying here or giving my opinion from theory. I am testifying as to facts, and I have tried to make it plain what I understand by menace and also what I understand by actual injury or unfavorable influence on the human system, quite short of frank disease or incapacitation, as we describe it. I appreciate what you say, that the Supreme Court will have to decide what it has in mind by those terms, but I am also aware that law and courts ultimately will have to square their decisions and their judgment with the facts of science and medicine; and, ultimately, in my
2983 judgment, I think the policy that guides us and you and the courts is to take all measures to minimize all these, any or all of these unfavorable conditions, that we can do within the practicability of our knowledge and our civilization.

Redirect Examination by Mr. Wallenstein

I consider the odors and the hydrogen sulphide as having passed beyond a stage of menace to an active detrimental agency to those people.

With permission of the Court, I might again try to clarify, because I think this is a very important case, what I mean by the depressant scientific and medical uncertainties, as to the danger of these minimal concentrations of unfavorable poisons; and I want to, if possible, guide the Court against the assumption, the common assumption, that where we have at present no
2984 method of discovering, no evidence of, injury, that we can then convert that into a positive proof that there is no injury.

For example, there is the Massachusetts Code of Permission of 20 parts per million of sulphuret hydrogen in the immediate air, and there is the Wisconsin Code of 10 parts. Now, all that means, scientifically, is that in that concentration we have not yet proven an injury, and I should like to guard the Court against the contrary assumption that we have proven it is non-injurious.

Examination By the Master

2985 The regulations in Massachusetts and Wisconsin are based on actual observation and experience, and then they are put lower as a matter of safety because of our
2986 present ignorance. My only remark was to the effect that we do not know today that even these lower standards are non-injurious.

Insomnia, sleeplessness, is not a trifling thing in the matter of health. As a matter of fact, we die from lack of sleep much more quickly than we die from lack of food; and sleeplessness, lack of sleep, is one of the serious questions in connection with disturbances of the nervous system. I hope the Court will not take lightly any condition that disturbs a person's sleep.

Redirect Examination By Mr. Clausen

2987 With respect to the Massachusetts Code and the Wisconsin Code they have had a period of years over which they have studied these problems as to the number of parts per million of hydrogen sulphide that might be detrimental to health; and yet, on the other hand, we have only a year and a half to compare conditions in the Brandon Pool, so that we can't determine those two measurements of parts per million. Of course, it is a fact that in science and medicine we make use of all reliable information in other places and other countries and other sources for our guidance.

Recross-Examination By Mr. Naujoks

2988 The subjection of the human system to new conditions that we have not been subjected to in the past, new substances and combinations of substances, are serious problems. I said that those are serious problems in biology and medicine, one of the most serious problems before us; and in our present ignorance our

only guidance is all practicable, feasible measures to minimize those influences to know just what is safe. I am a pragmatist. I would favor, if feasible, if practicable, economically possible, other methods or ways of ameliorating conditions in the Brandon Road Pool without any additional diversion of water.

Personally, I have lived here a long time, and this problem has been before me as a public-health interested man in this region for years, and I have lived
2989 on the lakes here and in the State of Michigan, and still live on the lakes in the two States. The amount of water asked for by the State of Illinois temporarily, or even during the summer, could not conceivably have any health significance for the other States; and I think it insignificant and uneconomic.

2990 My understanding of this petition is that this is not for a permanent increase but temporary, until the treatment is adequate. I think the Sanitary District is progressing very well with the treatment of sewage.

Recross-Examination By Mr. Cohan

2991 I am a physiologist, I am an investigator, I am a teacher of medicine; but I have been asked from time to time to assist both the Federal Government and other agencies in these public health matters, but I am not a public health official, professionally, or othwise.

2992 My attention was directed to the Brandon Pool and the people at Joliet in 1939, and then I made a very casual and private, for my own information, inspection;

but I have never been consulted by the Sanitary District or by the Health Department of Joliet or Peoria or the City of Chicago on this problem.

October 14, 1940

Direct Examination By Mr. Wallenstein

2786 DR. CLARENCE W. MUEHLBERGER. I am a toxicologist. A toxicologist is a person who makes a specialty of poisons, their effects on the body, their detection, analysis for them. I graduated from Armour Institute of Technology in Chicago, receiving a degree of bachelor of science in chemical engineering in 1920. I then did graduate work at the University of Wisconsin in chemistry and toxicology, receiving the degree of Master of Science in 1922 and Doctor of Philosophy in 1923.

2787 From 1923 till 1930 I was the State Toxicologist of Wisconsin and from 1924 to 1930 I was Assistant Professor of Toxicology and Pharmacology in the University of Wisconsin Medical School at Madison. During that latter period from 1924 to 1930 I was also the Staff Toxicologist of the State of Wisconsin General Hospital at Madison. In 1930 I came to Chicago and took up my work as the toxicologist in the Cook County Coroner's office and from 1930 to the present time I have been on the faculty of Northwestern University Medical School, first as assistant professor of toxicology and later as associate professor of toxicology. For the past five years I have been lecturer in toxicology at the University of Illinois College of Medicine, and for the past four years I have been professorial lecturer in toxi-

cology at the University of Chicago Medical School, and just recently, during the past few months, I have been appointed lecturer in toxicology at Loyola University Medical School.

2788 I am familiar in a general way with the Sanitary District Canal, the lllinois Waterway and the so-called Brandon Road Pool at Joliet. I have visited Joliet, not for the purpose of examining the pool, but I am familiar with the location of it.

I am familiar with the effects of poisonous gases on the human organism. Hydrogen sulphide has two actions, depending on the strength of the hydrogen sulphide and the gas which is brought into contact with the human. If it is very dilute then the effect is primarily that of an irritant. It irritates the mucous surfaces, those of the eyes, the nasal passages and the throat, and if it is presented to the body in high concentrations, then in addition to the irritation there is an asphyxial nervous depression resulting in symptoms of drowsiness, stupor and coma, finally causing asphyxial death with terminal convulsions.

Now the place where the concentration at which the irritating symptoms merge into the depressent symptoms is about seven hundredths of a per cent, that is, below seven hundredths of a percent the primary effect is that of an irritant. Above seven hundredths of a
2789 per cent, the nervous depressent effects become controlling, and from then on it is an acute poisoning in which the nervous symptoms are predominant.

Subacute poisoning depends upon the concentration of the hydrogen sulphide in the atmosphere which is breathed, and also the duration of the exposure, that is,

both factors have to be taken into consideration, the strength of the gas and the length of time it is breathed.

Hydrogen sulphide, outside of the chemical laboratory and in chemical manufacturing establishments, is found wherever any organic material which contains sulphur putrefies. That means we will find it in sewers, places where sewage putrefies and decomposes. We find it among tannery wastes and stockyards wastes which is permitted to putrefy and decompose. You find it in the gases which come from certain oil wells where there is sulphur in the oil, and which gases are rich in hydrogen sulphide. You find it in mines where sulphide minerals are mined. You find it in sulphur mines to some extent—that is, gas pockets. You find it
2790 to some extent in the gases which result from the explosion of black powder, although it is there to a minor extent.

The best way of detecting hydrogen sulphide without chemical means is by means of your nose, if you have a good sense of smell, because it has a very pronounced rotten-egg-like odor.

It is possible to be overcome by hydrogen sulphide gas in a place or location which is not inclosed. Whenever the concentration of hydrogen sulphide becomes high enough, it doesn't make any difference whether it is enclosed or whether it is out in the open. If the concentration is high enough and the person breathes it long enough, he will suffer the symptoms of poisoning and they could easily result in stupor or even coma. There are numerous references in medical literature of persons being overcome by the gas in open places. I believe Mr. Yant's article in the American Journal of Public Health cites many instances of people being

2791 overcome by hydrogen sulphide in open places. Fatalities which have occurred in unenclosed places would indicate that there has been a suffiicent high concentration to be fatal.

The decomposition of sewage containing human fecal material is usually accompanied by the release of hydrogen sulphide gas. The symptoms of subcute hydrogen sulphide poisoning are irritation of the mucous surfaces, primarily those of the eyes, which result in a burning sensation of the eyes, irritation of the nasal passages, resulting in burning and sneezing and constriction of the nasal passages, and burning sensation in the throat, producing coughing, and if the irritation is severe enough, it may go on to a sufficient extent so that the person not only has the irritation but they feel nauseated and they may even vomit as a result of the prolonged exposure to low concentrations of the hydrogen sulphide.

2792 I would say that such a method of analyzing gallon samples of air taken at points near the canal for detecting small amounts of hydrogen sulphide, as given in Mr. Bergman's testimony at page 2712 of the record, was practiaclly worthless for two reasons. In the first place the strength of his solution is so great that if he used gallon samples and used tenth normal iodin and thiosulphate, as little as one cubic centimeter of his so-
2793 lution would be equivalent to one c.c. of hydrogen sulphide in a gallon of air sample, which would be one part of hydrogen sulphide and 3875 parts of air or, roughly 300 parts per million, which would be about the minimum that he could accurately determine with such a strong solution.

In the second place, you can't bubble air through tenth normal iodin solution without losing some iodin. Iodin is volatile. As a matter of fact, you can take iodin solutions and smell the iodin. You know it is being volatilized. So the passing of air through iodin is certain to cause a loss of iodin, and especially in the summer time that loss would be material, and unless it were corrected the results would be entirely erroneous on the basis of the loss of iodin from even pure air bubbled through an iodin solution.

2794 I certainly don't agree with the answer of Dr. Enzer, at page 2161 of the transcript to the question "If for example, by a calamity the sewage system of any large city were destroyed by bombs or otherwise, and you had a lot of untreated sewage, would pestilence ensue" to which he replied—"It would ensue because such untreated sewage would contaminate drinking water or food—and only in that way". In addition to the spreading of bacteria there is a possibility that the toxic gases given off in the decomposition of such sewage could produce illness and possibly death—although that is rare—to people who are exposed to such gases.

2795 Yes, I think an approximate concentration of .0025 per cent of hydrogen sulphide would be required to blacken and discolor the paint on houses located approximately 750 feet from the canal, as testified by Dr. McNally. I think that is a reasonable average. You can't put a definite concentration below which houses won't be blackened. .0025 per cent represents 25 parts per million. It depends on how long it is going to be inhaled as to what I would consider the maximum concentration of hydrogen sulphide in the atmosphere

for safety. For constant exposure I would say from 10 to 20 parts per million is certainly as much as should be permitted. For the average person exposed to under
2796 50 but over 20 parts per million, the symptoms would be purely those of irritation—irritation of the eyes, of the nasal passages and the throat. There would be no systemic symptoms in the average individual. Now, there are persons who are more susceptible than others and to a person who is susceptible and easily influenced by hydrogen sulphide, that person might show more profound irritation, possibly even nausea or vomiting. In the capacity of State Toxicologist of Wisconsin from 1923 to 1930 I have been consulted by state agencies concerning the possible harmful effects of toxic gases. The Wincsonsin Industrial Commission instituted an investigation into the hazards of industry in the state of Wisconsin. A committee was organized which was composed of several representatives of labor appointed
2797 by the various labor unions of the state—several representatives of industries as appointed by various large key industries of the state, I believe two medical men were appointed by the medical society, and then there were two representatives of the general public. I represented the general public of the State of Wisconsin as the State Toxicologist concerning matters of possible poisoning, and Mr. Muehlstein represented them as the engineer of the Wisconsin Industrial Commission concerning matters of engineering aspects of ventilation and so on. We not only investigated toxic gases, but we made recommendations concerning toxic vapors, gases, dusts and fumes and we made recommendations concerning the limits which were to be permitted in

the working atmosphere in the State of Wisconsin. There was a table propounded of limits for safe practice.

2798 This table of safe limits for toxic gases was embodied in the report of our committee and the report was adopted by the Wisconsin Industrial Commission as an order to industry for the regulation of ventilation in factories and workshops.

(Pamphlet entitled "General Orders on Dusts, Fumes, Vapors and Gases" issued by Industrial Commission of Wisconsin was thereupon identified by witness)

That is the order of which I spoke. The table is on page 20 of the order.

2799 The table is entitled "Harmful Concentrations of Various Materials, by Volume, in Parts per Million" and under hydrogen sulphide the limit is listed as 10 parts per million, giving "slight symptoms after several hours or maximum amount for prolonged exposure", and under the table of "Hazardous limit for very brief exposure" it is 1000-2000 parts per million, which is one-tenth to two-tenths of one percent.

(Said pamphlet thereupon was marked "Muehlberger Exhibit No. 1", and introduced in evidence)

2801 In 1924 to 1930 I thought it was in the interests of the public health to recommend such a limit for the breathing zones of workmen in Wisconsin factories. I am still of the same opinion because hydrogen sulphide is a very poisonous gas. It is just as poisonous as hydrocyanic acid or prussic acid, which is another name for

the same thing. I am familiar with the report of "Code for Safe Concentration of Common Substances used in Industry" published by Doctors Drinker, Hamilton and Haggard in the June (1940) issue of the Journal of Industrial Hygiene. The limit set by them for safety
2802 in hydrogen sulphide is 20 parts per million.

I have examined the transcript of the testimony taken from witnesses residing in the City of Joliet in this case. I would say that the nausea, headaches, insomnia, loss of appetite testified to by the residents of
2803 Joliet may have been caused by hydrogen sulphide. I do not agree with Dr. McNally who, at page 2701 of the transcript, said if trains went by and gave off hydrogen sulphide in the smoke, and they do give off hydrogen sulphide and sulphur dioxide, that would be sufficient ot cause a discoloration for some distance away. Trains burning coal which contains sulphur give off sulphur dioxide, but they don't give off hydrogen sulphide.

2805 It is my opinion that hydrogen sulphide caused the discoloration of the houses along Railroad Street abutting Brandon Road Pool, and the household utensils to which Mrs. Beulah Booklund testified at page 906 of the transcript. In judging the amount of gas present, the intensity of the odor is very unreliable because, especially with hydrogen sulphide, the nerve endings of your nose become paralyzed after you have smelled it for a while. It is a common observation in chemical laboratories where they are using hydrogen sulphide gas that as you enter the laboratory you smell the stink, but after you have worked in the atmosphere for a while, you don't notice the stinking odor any longer. In other words, the nerve endings no longer send their

2806 warning to you that there is a stink there. You do notice the irritation of the eyes and the throat, but the smell itself is very much less than it was originally when you came from fresh air into the hydrogen sulphide contaminated atmosphere. There are many odors other than hydrogen sulphide given off when sewage decomposes. In general some are organic sulphur compounds, indol and skatol, mercaptan, cadaverin. Those have offensive odors also.

2807 After reading the transcript of testimony given by the residents of the City of Joliet and those people working in St. Joseph's Hospital, and based upon my experience and knowledge of the conditions that surround the Illinois Waterway Canal it is my opinion it is a very definite menace to the health of the people of that region.

Cross-Examination by Mr. Cohan

8208 As a citation of recorded instances of persons having been overcome by hydrogen sulphide gas out in the open I refer you to an article by Mr. William P. Yant in the July 1930 issue of the American Journal of Public Health. It is about page 598 or 600. That is one of the sources of my information. The other sources are the standard textbooks on toxicology, including the two texts of Dr. William D. McNally, the text written by Kobert, the German work on Schadlichs Gase, by Flury and Zernik. These are examples I have read about. I haven't had hydrogen sulphide poisoning in either Chicago or Wisconsin in open places.

2809 Except these cases of mild poisoning indicated by this transcript I am not familiar with any cases of hydrogen sulphide poisoning in the region of this canal. As to there being no serious cases reported in this transcript it depends on what you mean by "serious". The people didn't die from it or they weren't rendered so ill as to require hospital treatment or anything of that sort. They might have been rendered very uncomfortable and very unhappy. I wouldn't want to be put in the position of thinking that was a serious illness.

2810 As a definition of menace to public health, I would say that this transcript indicating the degree of unhappiness caused in the people who testified here was sufficient to prove a menace to public health. I believe that people are entitled to a decent place in which to live, comfortable surroundings where the air that they breathe is perfectly good, healthy air, and I believe that anything which contaminates the air so that they aren't in a good sound state of health is a menace. You don't have to kill a man to have a situation which is certainly a menace.

I spoke just of the inexactitude of Mr. Bergman's method of determining the presence of hydrogen sulphide. There are other methods which are more exact. I didn't try any of those methods with respect to the presence of hydrogen sulphide near this waterway because I was just called into this case and there is no use going down there now because the time to make the test is when the odor is bad, which is the middle of the summer. Here we have still a pronounced odor,

but not so much putrefaction, not so much decomposition as you would have, say, in the latter part of June, July and August. Here we are in the middle of October when things are cool and when the gases that come off
2811 are still unpleasant but are certainly not as rich in hydrogen sulphide as they would be during the hot summer months, especially on muggy days when there is no breeze to dilute the gases which come off of the canal. The menace to which I have referred probably exists through the year, but I believe it is very gravely accentuated during the hot summer months, at least it has been my experience just driving along there that I notice the tightness in my throat and the irritation in my nasal passages more in the summer months than I do in the winter time.

October 16, 1940

Direct Examination by Mr. Wallenstein

3032 DR. ANDREW CONWAY IVY, received Bachelor of Science degree from the University of Chicago and Master of Science, Ph.D. Degrees from the same institution, the M.D. degree from Rush Medical College. The Ph.D. degree was granted in the field of sociology, pharmacology with a minor in pathology. I have taught physiology and pharmacology at Loyola University
3033 Medical School, at the University of Chicago, and in 1925 I became chief of the Division of Physiology, Pharmacology, Materia Medica, Toxicology, Northwestern University Medical School. I belong to the staff of Passavant Hospital and have a license to practice

in the State of Illinois and I have consultation in private practice.

At present I am President of the American Physiological Society and American Gastrointeriological Association. I have been a member of the Public Health Committee of the City Club for a number of years and I took part in the campaign to obtain a filtration plant for the South Side, and at that time I had occasion to study questions pertaining to sewage disposal and the procural of water from Lake Michigan and water pollution. I had to gain that information and make a study of that problem because it fell upon me to make about 30 speeches to various men's clubs and women's clubs and groups in order to convince them of the importance and the neecssity of having a filtration plant, particularly on the South Side where the water was rather heavily polluted at times and for a number of hours during the year was definitely above the standard requirements of the United States Public Health Service.

3034 I am familiar with the Illinois Waterway and the so-called Brandon Road Pool at Joliet. I had occasion to visit, and observe the canal during the year 1939. I happened to be taking an automobile trip with my family. I was going to the meetings of the American Medical Association in San Francisco. When we crossed the canal in Joliet we noticed the odor and also islands of scum in the waterway. I think that was the latter part of June 1939.

I have read the transcript of Professor Carlson and

3035 made a trip in the company of Professor Carlson on Sunday, October 13th, as I recall, 1940. I visited the same points that he described. I have read the tran-

script of the testimony of the residents of the City of Joliet, the nurses, nuns and doctors attached to St. Joseph's Hospital in Joliet and the local physicians—five or six volumes of testimony. And I have read the testimony of Thomas Testim, the chemist, particularly with reference to the tests of water of the Sanitary District Canal during the summer of 1940. I understand that one of the questions before the Master is the question of what constitutes an actual menace to health.

From the medical and physiological standpoint the factors I would consider in determining the question of whether or not a waterway or stream or a pool is an
3036 actual menace to health are, first, I should consider whether any existing detriment is present as a result of the pollution of the waterway and, second, I should consider whether the waterway is a potential menace, that is, whether it hangs over the community as a sort of threat that may cause disease some time.

From my personal inspection and observation of the canal and from a reading of the transcript of the testimony of the lay witnesses, nurses, doctors, of the City of Joliet, I believe that the health of some of the members of that community is being detrimentally affected at the present time. From my observation of the waterway, the so-called Brandon Road Pool and the Sanitary District Canal I believe that it constitutes an actual menace to the health of the community of Joliet. In the first place, the pool impressed me as being a cesspool that was uncovered. Generally when a cess-
3037 pool is present or is constructed, it is supplied with covers to prevent flies from being contaminated and spreading disease. Then I am convinced of the truth

of the dictum or general principle that pollution of the air or of streams is unhygienic or unhealthful, and that they should be abated, if possible. Continuously in society we are trying to improve unhygienic conditions of living because we regard them as being unhealthful. We abate smoke; we abate noise; we abate dust; we try to abate pollen distribution because of the hay fever sufferers; we abate stray dogs because of the threat of rabies and the spread of disease by stray dogs, and when a water supply is even threatened with pollution we immediately take steps to take care of the situation, and it is on the basis of generalization and principles of that sort that I believe that there is an actual menace to health existing there now.

3038 Yes, I noticed an odor emanating from the canal on the occasion of my visit there last Sunday. We examined particularly what we were told to be the Brandon Pool from the locks and dam along the retaining wall almost back to the McDonough Bridge. I obtained the odor of hydrogen sulphide plus the type of odor that one obtains from a cesspool, some trace of indol and skatol. It was a cool day. The pool was bubbling. There was scum only around the edges of the retaining wall and the dam and the retaining wall of the locks, and we got this odor in different spots. It seemed as if you could smell the odor at certain times and at other times you could not, and two explanations of that occur to me: One is that the gas would bubble out and tend to pocket because of convection currents in the air. There was not much of a breeze at the time. Secondly, because of the possibility of the occurrence of olfactory fatigue which occurs when one smells hydro-

gen sulphide or other odors. I happened to experience after smelling some four or five of these areas in which the odor was rather strong, a metallic taste, and then because I lecture so much—I just lectured two hours last evening and another hour this morning, frequently three hours a day—I have a rather sensitive nasal pharynx which is irritated by smoke, that is, coal
3039 smoke, and is irritated, for example, by the fumes of Whiting. I live on the South Side, and after I got home I noticed irritation in my nasal pharynx. I don't recall having noticed the odor when I visited the point directly across from St. Joseph's Hospital, on the other side of the canal on Sunday. It made no impression upon me, but in 1939 I noticed the odor when I crossed the bridge in Joliet. Yes, I recall going up on the retaining wall on the east side. I got out of the car and walked along the base of the retaining wall to look for some seepage water. I noticed the railroad pumping station was working, and I walked up on the wall and saw the water bubbling, and I obtained the odor there,
3040 as well as down at the locks on the dam. I observed some of the homes of the inhabitants of the city were located or were situated at a level lower than the level of the Brandon Road Pool. Particularly I recall that was true on the east side of the pool. I might say that while I was making that inspection and looking for seepage of water through cracks in the retaining wall, we inquired of the man living there as to whether or not when the storm came up if any of that water splashed up over the retaining wall and on the retaining wall.

3041 I believe that since it has been testified that the odor has caused nausea, vomiting, disturbance of appetite and disturbance of sleep, that it is an unhygienic condition and works as a detriment to the health of the people that the odor so affects. Now, that would be particularly true of children who do not have a good appetite. That would be true of patients in the hospital convalescing, invalids, where it is important that their digestive apparatus is not upset or interfered with and their appetite is not affected, and at times it is conceivable that the odor may, or the hydrogen sulphide may be sufficient to irritate sensitive respiratory mucous membranes. That would, as I indicated, tend to delay recovery and to interfere with the proper growth and nutrition of children.

3042 If the concentration of hydrogen sulphide were sufficient, one would be able by examining the mucous membranes to detect irritation, but the odor itself that nauseates would not show up in ordinary public health statistics. It would be something that would predispose to infections of the respiratory tract and prevent the recovery of convalescent patients whom we want to eat and whom you desire to digest food, and the same would be true of children who do not have good appetites. The effect of hydrogen sulphide gas upon the human nervous system, the heart and other organs that would be affected, depends upon the concentration of the hydrogen sulphide. Most people detect the odor of hydrogen sulphide in a concentration of about .13 parts per million. Now, that is subject to variation, depending upon the sense of smell. The odor would nauseate some persons and not others, and it would

depend upon how accustomed one would become,
3043 whether or not they would develop olfactory fatigue. In the higher concentrations it would irritate mucous membranes and the mucous membranes that it would irritate would vary in different individuals, depending upon their sensitivity. If an individual had a sensitive conjunctiva, just normally sensitive conjunctiva, then the conjunctiva would be irritated first. If they had a sensitive mucosa in the sinus or nasal pharynx or in the lungs, that would be irritated first. Generally, a concentration of about 20 parts per million is considered to be the limit of tolerance—when one is exposed to it as an industrial hazard—and, of course, if you get up to around a thousand parts per million, then acute symptoms result and death may occur in a relatively short period of time, such as one or two hours, depending upon the resistance of the person or animal
3044 subjected to that concentration of gas. I believe that concentrations of from 20,000 to 40,000 bacillus coli per cc and concentrations greater than 10,000 pyogenic cocci, staphylococci and streptococci per cc in the water of the Illinois Sanitary District Canal constitutes an actual menace to the health of the community of the City of Joliet and the surrounding area. Such concentrations of B. coli indicate rather heavy pollution of the stream and it is possible for flies to become contaminated and spread disease through the community. Only one person would have to become infected and serve as a carrier or as a distributor of disease such as dysentery or typhoid. The staphylococci might presuppose to impetigo, for example, which is a disease of the skin that generally occurs around the face, par-

ticularly in children. Then it is possible that dogs or cats or other animals might get into this water and carry organisms away on their feet, or playing with children, and then I notice that Joliet gets their water supply from deep wells which are properly cased, but we never know when a fissure in the stone or the earth is going to form or when these casings are going to break down, and if there is a high pollution of the water in that stream, then the water supply of the city is in danger. Those are potential menaces.

3045 I don't think the fact that the present communicable disease rates of the City of Joliet are no higher than in other cities of the state that would be a factor in determining whether or not the Illinois Sanitary District Canal in its present condition is an actual menace to the health of the community. I don't think that this canal would increase the incidence of diphtheria or of communicable diseases of that sort, or small pox, and it may not have caused an increase in typhoid or in dysentery, but it may in the future do that. You can never tell when it might do it.

In those individuals in which the odor causes nausea and vomiting, such disturbances of digestion, it is my opinion that foul odor is an important part in reducing vitality and predisposing to disease. The acuteness of the sense of small varies markedly in different individuals. Some people are hyperosmic. They are very sensitive to odors and some people are anosmic, that is,

3046 they smell nothing, and others have blind spots, insofar as odor is concerned. We can perceive odors much more readily when the air is moist than when it is dry because the solution is facilitated so that the sub-

stance stimulating the olfactory nerve endings of the mucosa can penetrate more readily.

Q. (Mr. Clausen) It appears from the evidence that conditions at the Brandon Pool were much worse in 1939 than in 1938, and in 1940 were better than 1939 but worse than 1938. Now if it is true that the witnesses didn't suffer nausea and vomiting and insomnia and loss of appetite prior to 1939, but suffered these symptoms subsequent to 1939, would you say that such is evidence of their coming about in 1939 or 1940 a condition resulting in an actual injury to the health of some of the people in that community?

A. If there was no odor present prior to 1939 to
3047 cause nausea and vomiting and disturbance of sleep and irritation of sensitivity mucosa, then if the odor were present in sufficient intensity in '39 and '40 to cause those things, then I would say that public health in general was not as good in 1939 and '40 as it was in 1938.

I would also say that—although there is no evidence of death or hospitalization or even a doctor's care resulting from conditions existing in 1939 and 1940 at Brandon Pool, and only the symptoms that have been testified to by these various witnesses—their health has since January 1, 1939 become impaired by reason of such conditions existing, because it is not healthy for one to be so affected by odors as to cause nausea and vomiting and loss of appetite. It is also true that the effect on the health of some of the people in the vicinity of Brandon Pool by reason of conditions there, although not actually traceable to such conditions, still exist.

3048 In my visit to the Illinois Waterway last Sunday I did not get up to Lockport. I have not been through Lockport for a number of years. We got just as far north as St. Joseph's Hospital. I made no analysis of the water. I made no analysis of the air except the analysis one makes by sense of smell. I made no chemical analysis or bacteriological analysis. I made no analysis of the scum on the surface of the water. I did not notice any oil odor when I was there, although I saw the bank was stained in places, a type of stain that one would
3049 ascribe to oil; in places there was a little oil on the surface.

I would not agree with the statement of Dr. Evans in previous hearings in this case that the typhoid rate is a general index of the health of the community; that is, if the typhoid rate is low then the health of the community is good, while if the typhoid rate is high the health of the community might not be so good, because typhoid is only one disease. When you introduce sanitary measures you would abolish the incidence of typhoid, yet there might be other conditions present which would make the health of the community very poor. As to the testimony of Dr. Ferderick, Health Commissioner of Joliet, Illinois, in these hearings, that the health of the community was very good I should say that the health commissioner of the town or a community only knows to a certainty the incidence of communicable diseases. Those are diseases that are reported directly to him. He may not know anything
3050 about minor ailments and complaints, such as gastro-intestinal upsets. He may know nothing about the

presence of mild dysentery epidemic unless that happened to be reportable in the particular city in which he is health commissioner. In many cases of mild dysentery epidemics are not reported to the department of health unless they find Shiga type of dysentery and analyze the feces to make a specific diagnosis of the type of dysentery that the patient is suffering from.

I do not believe that the statistics on health which are reported by the health commissioner to the State Board of Health are necessarily an index of the general health of the community. They are an index of the incidence of communicable diseases—of reportable diseases. It will give you no idea of the time of recovery, give you no idea of the rate at which the children grow. It will give you no idea of the incidence of sinus disease, the frequency of recurrence of sinus disease. The only way that you can get an idea of that sort is by talking to the practicing physicians in that community and to hospital authorities. In regard to complaints and disturbances of that kind which are real disturbances of health, and represent an index of the health of the community, you can only get that from people who are actually dealing with sick people
3051 every day and are observing them.

The fact that for the first six months of 1940 there were no cases of typhoid fever reported in the City of Joliet and for the year 1939 there were eight or nine cases reported, all of which were obtained at Manteno by residents of Will County who are employed there, would not affect my conclusions. That only means that this potential menace as far as typhoid is concerned has not appeared on the surface yet; flies not lighting

on the edges of this pool or material coming from the pool have not infected anyone with typhoid, the fissures have not opened into the water supply, cats and animals have not become contaminated by coming into contact with the pool and then with persons living in Joliet.

It is my theory that this stream being polluted with untreated sewage should be cleaned up in some way; that is, it is a bad thing for a community to have. I believe that it should be treated at its source and I also believe that other towns along the stream should
3052 have their sewage treated, but as I understand the case, it is only a request for a temporary increase in water diversion for the purpose of dilution. Now, if you dilute this that will decrease the menace but will not eradicate it. The only way it can be eradicated is by proper treatment of the sewage, and if that is not 100 per cent efficient, then there should be enough water added to dilute it.

I think it is a fact they have had this menace, if any, for 40 years or more, ever since this polluted stream has been going through Joliet. It is my opinion that any stream polluted and laden with untreated sewage
3053 would be a menace to health, and that menace would be increased if a stagnant pool were created, as it has been here, since 1933, and even if you dilute the stream with an additional 3500 cubic second feet of water you don't remove the menace, you just decrease it. The menace is still there, whatever it may be, unless it is diluted to the point where you get to a stream that has more bacteria in it, B coli in it, than can be kept out. I don't believe that 3500 cubic second feet of addi-

tional diversion would remove entirely the menace I claim is there. It would depend a great deal upon the amount of oxygen that would be added to the water and the degree of dilution of the B. coli. I would like to see actual counts of B coli. I don't know how much the addition of that specific quantity of water would dilute the water in Brandon Pool.

3054 The approximately 150,000 pounds of oxygen per 24 hours which it has been testified an additional 3500 cubic feet of water would add would certainly help but I don't know whether it would entirely eradicate it. That would depend upon tests when that addition is made.

By Mr. Williams

I am not sure whether the typhus germ is destroyed by the presence of oxygen. Of course, there is another organism that may be present in a stream and that is ameba dysentery. I had that in mind when I referred to carriage by dogs and cats.

3055 It will depend upon the sensitivity of the individual as to how strong a concentration of hydrogen sulphide would be necessary in order to produce the objective symptoms described here, such as vomiting. I know that when our stomach is unstable from other causes, vomiting is more easily elicited by objectionable odors than otherwise. Sometimes our stomach is more stable than others. Some individuals are more sensitive than others. The lower limit of this sensitivity is a concentration necessary to produce the odor, sensation of rotten eggs, hydrogen sulphide odor, indol or skatol or

mercaptan; and the upper limit would be that that would produce unconsciousness or an exposure of sufficient length to produce olfactory fatigue. By olfactory fatigue I mean exposure to the odor for a sufficient length of time that its intensity so far as that person is concerned, depending upon his sense of smell,
3056 is much less. For example, that question comes up in the egg packing industry. One rotten egg would spoil a batch of egg yolks or of egg white, and they have girls who smell the eggs to throw out the rotten eggs, and they will develop olfactory fatigue; but if they inhale some fresh air for a short period of time, or if they inhale some contrasting odor for a short period of time, then they become sensitive to the eggs again. It would depend upon the mental association of the odor with unpleasant things in the past whether these persons at the lower limit of sensitivity would be similarly affected by any ill-smelling odor regardless of whether or not hydrogen sulphide is present.

By Mr. Naujoks

I believe an increase in diversion would by dilution decrease the number of harmful bacteria in the Brandon Road Pool. To what extent I can't state specifically.
3057 I do not know of one single case recorded in medical works or literature or journals, of an individual having been rendered unconscious by hydrogen sulphide coming from a waterway containing untreated or partially-treated sewage. It is a fact that the human system generates hydrogen sulphide in the colon at times and

dispels it in the form of gas. It varies in amount depending upon the diet and the amount of colon stasis. We have a means in the liver of taking care of any H2S that is absorbed in quantities of that type. You see this H2S is absorbed by the liver and is oxidized to a sulphate—an innoxious material; but that is different from the action of H2S on the mucous membrane of the eyes and nose and the respiratory tract. There is no detoxicatory mechanism there. You get direct effects of irritation, the reflex effects from the odor as well as from the irritation.

Hydrogen sulphide is generated as well from decomposing animal wastes, refuse. For example, in a farm
3058 yard, and so forth. Also from the petroleum industry at Whiting. There is some hydrogen sulphide given off by certain oils, particularly at times when oil is cracked. The odor is very noticeable at times if you drive through Whiting. It varies there considerably, but it would be very noticeable to any person going through if at that time there was hydrogen sulphide given off. I have smelled the hydrogen sulphide from Whiting at times when it has been pretty bad. A lot of people reside in Whiting near these oil-cracking plants.

3059 I would consider that detrimental to their health, and I think that should be abated. If I lived there I would be active in an attempt to reduce that because of health menace.

Q. (The Master) Could you compare that in terms of degree with this situation at the Brandon Road Pool? Would you say it was about as bad,

or would you say the Pool was worse or the Pool not as bad?

A. Well, there is a difference in the odor. When we smell the odor in the air at Whiting we know that it is coming from oil, hence it does not affect us psychologically, which is a real effect, as when we get the odor of H2S when it is associated with fecal odor, and then when we further associate it with its source and when we know that we can get disease by coming into contact with the water that is giving off an odor of that sort, a fecal odor.

You would get disease by coming into contact. I was developing associations. If we get the odor in the air at Whiting, we know that it is coming from oil; we know that oil is clean and we can't get typhoid or amebic dysentery or other diseases from that odor
3060 or from anything associated with that odor. I was pointing out that the effect of one odor might psychologically be more detrimental than the effect of another odor, even though those odors alone would be on the same footing.

Odors from the stock yards, in part, emanate from hydrogen sulphide, decomposing animal matter. There is some hydrogen sulphide in that odor. There is also
3061 some indol and skatol, and some individuals are nauseated by that odor. And again, I think that should be abated, and according to my understanding the people of the stockyards are doing their best, everything that is possible and feasible to abate it. At times that odor penetrates the city to the downtown section and up north beyond that. I drive along the Outer Drive twice a day, most every day in the year, and I

will get that odor about twice a year on the Outer Drive. That is a distance, as I recall now, of about a couple of miles. There are a lot of residential homes and houses in the vicinity of the stock yards that would be affected by the odor at times. I have had no personal experience in regard to the production of conjunctivitis by hydrogen sulphide. The addition of more water from Lake Michigan would not decrease the
3062 total number of harmful bacteria passing Joliet per unit of time. If you have a thousand bacteria in one gallon, or a thousand in two gallons, and if the one and two gallons flowed by a point at the same rate during the same period of time, there wouldn't be any decrease in the total number. According to my best knowledge and information increased oxygen would destroy more of it, but that is a different question from the first one you asked me. Bacteria—typhoid for example, according to my information do not live a shorter time in polluted water than they do in pure water. According to my information the number of B. coli per certain volume of water is an index of the pollution of the stream and an index of the danger of that water so far as typhoid infection is concerned. For example, the United States Public Health Service allows one B. coli per hundred c.c. Here, as I recall, we have all the way from 10 to 40,000 B. coli per 1 c.c. The number of B. coli in the intestinal contents varies, but there may be many of them in feces. Normally when
3063 the stomach is secreting acid, they are not present in the stomach. The acid of the stomach destroys them and will not permit them to grow. There are very few colon bacilli in the upper portion of the intestine. They

are principally found in the large intestine, and they are found there in large amounts; some are dead and some are alive.

I didn't say the odors at Whiting which are produced by hydrogen sulphide, and the odors from the stockyards which are produced from hydrogen sulphide, and those over a waterway which is polluted producing hydrogen sulphide from decomposing organic matter, would be the same excepting the psychological effect on the individual. There is hydrogen sulphide in certain of the odors that come from Whiting. There is hydrogen sulphide in the odors that come from the stockyards, but there are other volatile substances in the odors from Whiting that are not present in the odors from the stockyards. I live on the South Side of
3064 Chicago, about four or five miles from Whiting, and I have never smelled indol and skatol. I have never smelled anything suggesting the odor of fecal material and other than H2S coming from Whiting. Where I live I will get those odors from Whiting about five days out of a year, depending upon the direction of the wind, the humidity and the barometric pressure.

My residence is about 10 miles from the stockyards, but I get the stockyards odor once or twice a year when I come to the Medical School by way of the Outer Drive along the lake. I am much further from the stockyards than the people living along the banks of this stream at Brandon Road Pool. To make a comparison you would have to get some testimony from the people who live right along the stockyards.

3065 When I visited Brandon Road Pool last Sunday, October 13th, I did not notice garbage dumps below the

Brandon Road Locks. We were on the locks and walked out on the south retaining wall where the water spills over the dam, but there was not much spilling over when I was there.

By the Master

3066 Typhoid and amebic dysentery would only be carried through the air in the case that we had some infected water and the wind would blow a wave and that water would splash in our mouth. You would have to have the water itself in your mouth. If I had typhoid I could give it to you. For example, the most frequent place in the body for the typhoid bacillus to reside for any length of time, and it may reside there for many years, is the gall-bladder. Then it grows and proliferates the gall-bladder, comes down in the intestines and will be passed in the stools. Then the individuals will contaminate their hands, and then they will handle food and will pass it down. Of course, if they get it in the food that is cooked, then the typhoid bacillus would be killed with heat; but if they handle fruits and vegetables and biscuits and plates, then they can pass it. That is the way the famous "Typhoid Mary" infected so many. Amebic dysentery is distributed by carriers in the same way. Of course, they can infect foods in a number of other ways.

By Mr. Cohan

3067 In order for an odor to cause vomiting one must of necessity go through a certain amount of mental gymnastics. When most people become nauseated from an

odor it is due to the association of that odor with something unpleasant or an unpleasant experience. That, however, is not always true because the material may irritate the mucous membranes, we will say, of the pharynx, and reflexly cause nausea and vomiting. It stimulates sensory nerve endings from the pharynx and nerve messages go into the medulla and then motor impulses will come and cause salivation, which is an objective manifestation of nausea—which is a subjective sensation—and more impulses will come out that
3068 will cause the motor action of vomiting. For example, some irritating substance may be introduced into the stomach and will provoke vomiting; or, for example, sometimes a pain nerve is stimulated, and vomiting and nausea will be produced or provoked reflexly.

3069 These mental associations may occur subconsciously. You become nauseated and vomit without even thinking about it, for the present, saying "Well, that odor is associated with the odor of the feces, and that is why I am going to become nauseated and vomit", because certain of these things, reflexes go through in the subconscious portions of our brain. We are not aware of them. Just like we walk. Walk is a voluntary act. We initiate our walking and we stop our walking through the processes in the cerebrum, but after we start to walk we don't think about it; it is the subconscious act. Nausea and vomiting can be brought about subconsciously. As a matter of fact, we can take animals and produce vomiting, which is an objective manifestation of nausea which is subjective, without a cerebrum.

3070 It is possible for a good stiff smell of rotten eggs to cause one to vomit. I would say the jublic health in general of the City of Chicago, insofar as communicable diseases are concerned, infant and maternal mortality, the prevalence of typhoid, to be specific, is very good. Insofar as the prevalence of amebic dysentery is concerned, we have not had a good record. Insofar as the prevalence of irritations of the upper respiratory
3071 passages by smoke and dust, irritation of the nervous system by noise, and unhygienic factors of that sort, I would say it is not so good. If I were to be asked as to the general health in general of a municipality, whether it was good or bad, I could not give an answer yes or no—I would have to qualify it. As a matter of fact, there are very few things in science and medicine that we can answer a straight yes or no. In my opinion the degree of pollution of a stream passing through a municipality determines whether or not it is a menace
3072 to the health of the people living there, because it predisposes to the amount of odor given off and it increases the bacterial content. It depends upon the degree of pollution as to whether or not the stream is a menace to the health of the people of the community. Loss of appetite is not a rare thing.

3073 A few of the causes of loss of appetite in an individual are, first unpleasant odors; second, unpleasant surroundings, sight of unpleasant things in the environment; the presence of unpleasant associations in the environment such as business worries or domestic worries; and then, many acute and chronic illnesses and, of course, lack of vitamins, eating too much fat, too much sugar. The expressions insomnia and loss of

sleep are synonymous. I should say that they are rare disturbances. Vomiting and nausea are much more rare than the disturbance of appetite and disturbance to sleep.

3074 Nausea is a subjective sensation associated with certain objective findings when you study the patient, but vomiting is an objective phenomenon. You can see a person vomit but you can't see them be nauseated. Of course, they get pale and salivate. If you take their heart pulse rate you would find it would become irregular, slow down and speed up.

Hydrogen sulphide is by no means the only thing that irritates the mucous membrane. It can be irritated by chlorine, gas fumes of nitric acid, sulphuric acid. I can give a large list. Gasoline, for example, will do the 3075 same thing, fumes of benzine, fumes of ammonia, exhaust from a Diesel engine, smoke from certainly tobaccos. The presence of noise like the operation of elevated railroads passing by houses where people live would be an unhygienic factor and by disturbing the sleep of certain persons living along the elevated will interfere with their health—with normal healthy individuals. Therefore, in my opinion, it should be reduced and, of course, that is what we are trying to do in the cities by getting the street cars constructed so that they run more quietly. I would conclude that it would be a menace to the health of people living there. It is an unhygienic condition.

By Mr. Naujoks

3076 I couldn't say how many people at Joliet would be affected by nausea, vomiting, or otherwise if .2 of 1

part per million of hydrogen sulphide were in the air. I would have to go down there and test them out. .13 parts per million would stimulate the olfactory organs of some individuals; .13 is less than .2.

3077 I don't know how much smoke there is at Joliet or how much railroad traffic there is. Of course, I believe that if the smoke is excessive and if it is feasible to reduce the amount that should be done. That is why I am in favor of rigid enforcement of the smoke abatement ordinances in all of our cities.

Re-Direct Examination by Mr. Wallenstein

This psychological process, this process of suggestion —association is real. We are doing it all the time. We are all doing it during our discussion here. Sure there is a physiological response in the body as a result of

3078 that suggestion. Nausea is a physiological response; change in heart rate; change in blood pressure. The act of vomiting is a physiological response very definitely. Nausea and vomiting are very undesirable and one of the most common symptoms of disease.

Recross Examination By Mr. Williams

You would have to condition the individual to secure a similar result merely by the color blue in certain individuals. If, for example, we would select an individual who was nauseated and has vomited by the of asafetida, and if the color blue were presented with this odor of asafetida at the proper time and for a certain number of times, that individual would become

conditioned, or he would be educated or trained to vomit when he sees blue. You can do that with a dog or a rat. You can't do it with a rat because a rat doesn't vomit.

October 16, 1940

Direct Examination By Mr. Clausen

3079 HUGE ALISTER McGUIGAN. I reside in Evans-
3080 ton. I graduated with a Bachelor of Science degree, North Dakota State College in 1898. I stayed there for three years as assistant professor of chemistry. I came to the University of Chicago and was assistant professor in physiological chemistry. I got my Ph.D. degree in physiology and chemistry in 1906, a medical degree from Rush Medical College in 1908. I have been assistant professor of physiology and pharmacology at Washington University for four years; professor of pharmacology at Northwestern University for seven years and since 1917 I am professor of pharmacology and therepeutics at University of Illinois, College of Medicine.

I belong to the American Chemical Society, American Association for Advancement of Science, American Physiological Society, Biochemical Society, Society for Experimental Pharmacology and Therapeutics, Institute of Medicine in Chicago, Fellow of the American College of Physicians, and there are some others.

I have written several books. One "Applied Pharmacology", another "Materia Medica on Pharmacology for Nurses" and several previous to those.

3081 I accompanied Dr. Carlson and Dr. Ivy on a trip to the Brandon Road Pool, Sunday, October 13, 1940. I have read Dr. Carlson's testimony and I have heard Dr. Ivy's testimony. In the main I agree with their testimony. There are many things we could add. In the first place the hydrogen sulphide on which they are dwelling so much isn't the only thing. The cadaverin, putrescin and all the other things mentioned—those are positive things, but there are many other things that we won't know anything about in there which
3082 may be even more toxic than the hydrogen sulphide. For instance, 30 years ago I worked for a while in a government laboratory at Washington with Dr. Wiley and in those days we thought of food as consisting only of carbohydrates, fats and proteins. Now we have developed things that were entirely unknown, that are just as important, like the vitamins. The same way in the chemistry of this sewage business. We know some of the big things, some of the positive things; but there are many other things we don't know anything about that may be more toxic than the hydrogen sulphide, which I think they are according to the evidence given. There are other things in there, in my opinion, that are more toxic than hydrogen sulphide could be in the concentrations that could exist.

I spent three hours on the transcript of the record. I got, I think, the main points of it. I went through
3083 that list showing the effect on the various people. (The Master: The list referred to is a summary of the testimony at Joliet which Mr. Naujoks prepared and furnished copy to opposing counsel). It is my opinion that an actual menace to the public health

exists in the community of Joliet. The weight of some of the people who testified didn't seem to change even though they were affected. Weight can remain the same and a person be very markedly affected. The composition of the human body is, roughly, say two-thirds water. A person can lose a great deal of actual flesh and remain the same weight because they drink more water. In diagnosis, the actual weight means
3084 the weight may be the same and the person may be really losing weight.

Another thing, I think you are paying too much attention to statistics of public health. I think half those people could be sick and it wouldn't be mentioned in the public health records. They could be out of work and suffering from something that wouldn't show in the records at all.

3085 Very frequently people might have these particular ailments by reason of these conditions and still not go to a doctor. I didn't ask some of the people I talked to if they had a doctor, but they complained of being sick. On the ordinary headache you might get more information from the actual number of headache remedies which are used down there. The medical profession object to people medicating themselves. One of the things that is most used is the ordinary
3086 headache remedies. That don't show in any records at all, even in drug store records. If hydrogen sulphide is injected into frogs you get a strychnin-like tetanus that may persist for two weeks. It shows definitely that hydrogen sulphide has a very definite effect on the central nervous system.

Cross-Examination by Mr. Williams.

3087 I think the meaning of the term "detrimental to health" means anything which causes impairment or deterioration of or is detrimental to the full functioning of the human system. I would say if a person was 100 per cent healthy we could apply the converse term and say that a healthy person is one who has a 100% full function and coordination of his being, but few people are 100 per cent healthy. Using the term in that sense it is a debatable question where I know of any healthful people. We take the average man's health and say he is a healthy individual—reasonably healthy.

I would accept as a correct understanding of my testimony the statement that there may be conditions existing at Joliet which are detrimental, but which are unknown for the reason that the causes are
3088 unknown. If you don't know the causes you can't eradicate it. In many cases it would also follow that if we didn't know the cause we could not ameliorate it or make it better. Many cases we can. We don't know the cause of cancer, for instance, but we can ameliorate it a lot. But in the sense that I am now using cause, we have an objective symptom in can-
3089 cer. So far as presently known there would be no method of remedying that situation until the cause and the observable results were known.

By Mr. Naujoks.

If you had a large number of people ill in any community that would be reflected in the mortality statistics only if they died. They might be more apt to

die if they were ill because of their reduced resistance to most diseases. When I mentioned headache remedies I wasn't meaning to imply that they were
3090 sold only in Joliet. I am in general agreement with Dr. Ivy's testimony, both on direct and cross examination.

By Mr. Herbert.

3091 Earlier in direct examination I stated substantially that there might be other things in that condition down there, in addition to hydrogen sulphide,—unknown things which may be creating a bad health hazard. By the same token I don't know of anything in that stream—unknown things—which may be healthful to that community. The question asked of Dr. Ivy here was if bacteria would live as long in a polluted stream or shorter time in clear water. What he was referring to was a bactericide, something that was eating away the bacteria. So far as some of the bac-
3092 teria is concerned, your statement may be true. How far that would apply to the general community I can't visualize anything in that stream that would be helpful to the community as a whole. My motive in bringing into this record the statement that there may be unknown things down there at Joliet which are detrimental to health was based on the testimony I have read of the priests, nuns, doctors and all the others. I can't see how a concentration of hydrogen sulphide in itself would be the only thing that would do that or could do it. There must be, in my opinion, something else there.

3093 I was first conculted with regard to testifying in this case a week or ten days ago, and that is the first time I have ever directed myself consciously to this situation at Joliet.

By Mr. Naujoks.

It is not so likely that these unknowns might be, for example, gases from the refinery wastes, oils and things. I would confine them mainly to protein products, decomposition products. The gases we know pretty well. There is none of them toxic that we know of in any ordinary concentration, in the petroleum industry.

3094 You can get overcome with gasoline, but in enormous concentration. For instance they have actually used gasoline as an anesthetic, but have given it up because it is dangerous and uncontrollable, and so on. You can kill a man with anything, even pure oxygen. In certain concentrations that is toxic.

By Mr. Cohan.

On the basis of this record we have a real sick 3095 community in Joliet. According to this record I have read, you have a serious condition there.

By the Master.

I can't say that I am a practicing physician. I am licensed in the State of Illinois to practice and I have some consultations, but I wouldn't rate myself as a 3096 practitioner of medicine. My field is particularly phar-

macology and therapeutics. In pharmacology I deal with the action of drugs and in therapeutics with the application of drugs to the treatment of disease.

By Mr. Herbert.

I don't think I examined the convalescence records of the hospital down there at Joliet. Assuming that the average convalescence from any type of illness would be the same in Joliet as in any other community, that would have no influence on my conclu-
3097 sions. The reason why is that we have never seen a patient in a hospital yet who didn't want to go home before he should go, and at Joliet where the conditions were nauseating, as they state here, he would want to go still earlier, so I don't think the record would be of any value in that case.

3098 By Mr. Naujoks.

The fact that no one of these witnesses who testified at Joliet lost any time from work wouldn't change my opinion that Joliet is a sick community. They wouldn't be incapacitated for work, but those people who have to work, in my opinion, get out where if they had a little more money they wouldn't go to work.

September 23, 1940

Direct Examination—Mr. Clausen.

2136 C. E. SCHWOB. I live in LaGrange and work in Chicago. I am Assistant Sanitary Engineer for the Department of Health, State of Illinois. On June 20,

1939 I took a picture along the Sanitary Canal where Route 45 crosses the Canal right south of LaGrange. That is between Summit and Willow Springs.

2137 At this point witness identifies picture which is offered and received in evidence as State of Illinois Exhibit 58.

That picture was taken about six o'clock in the evening.

2139 A barge had just gone down the Canal and the reason I was particularly interested was that there was a slick on the water from the boat passing through and the rest of the Canal where the boat hadn't gone through was completely covered with sludge. I took it merely from the interest of public health.

Yes I could see the barge from where I took the picture. That black spot here (indicating) is the barge going towards Joliet.

At this point witness identifies an enlargement of the above mentioned picture, which is offered and received in evidence as State of Illinois Exhibit 59.

2142 Before the barge went through a scum covered all across.

Cross-Examination—Mr. Cohan.

2143 When I see things of that nature that are of interest from a public health standpoint I take pictures of them. I gave the small photograph to the Chief Engineer, Mr. C. W. Klassen, of the State Department of Health. No one from the Attorney General's office asked me to take that picture.

228 CHARLES L. ADAMS, on behalf of Petitioner.

Direct Examination by Mr. Clausen.

I am a graduate of Miami University, A.B. 1924, and received an M.S. in Chemistry from the State University of Iowa in 1925. I have been with the Sanitary District 15 years, of which 12 years was spent in charge of the Joliet Laboratory.

229 I cross the Des Plaines River daily, morning and evening. I analyze about 60 samples daily for dissolved oxygen. The samples are collected for dissolved oxygen hourly each day except Saturday. The B.O.D. samples are collected every four hours.

230 I look over Brandon Pool every week on way to Smith's Bridge Station. Once a month I run down to Peoria, collecting samples every five miles. In a month I make a total of 1200 tests. Such tests have been made for 15 years. I have personally made them for 12 years.

231 I report to Dr. Mohlman on results at Lockport and Smith's Bridge. The Brandon Pool was in much worse condition in 1939 than in 1938, and was also worse in 1940 than in 1938.

232 Warm weather brings the sludge to surface. This action stops with advent of cold weather in fall. The water was worse in the Pool in 1939 after cut in diversion. Odor changed to a characteristic nauseating odor in 1939 and 1940. The odor in 1938 lacked the sickening quality of 1939 and 1940.

233 The B.O.D. increased in 1939, and was higher in

1939 and 1940 than in 1938. In 1938 I made seven round trips through the Lock at Brandon Road. I was on the Pool seven times. In 1939 I was on the Pool four times, and in 1940, I was on the Pool four times prior to July 12. The river improves definitely near Dresden Pool, about one-half mile above Kankakee River.

LORAN D. GAYTON.

3538-3545 Gayton Exhibit 1, Affidavit.

I have been in Engineering Practice for 35 years. During this period I have been in the employ of the City of Chicago for 26 years, including 13 years as City Engineer. As such I have charge of the Water Department. The number of water services in 1940 in Chicago was 412,228. Of these 115,025 services are metered. To install universal metering requires 300,000 meters. The cost of meters installed is estimated at $10,400,000. This installation would require 5,640,000 man hours, and might extend over at least six years, but more likely twelve years. In ten years from 1930 to 1939, the City placed 41,564 meters, or an average 4,156 per year. The greatest number placed in one year was 16,864, in 1931.

The cost of water to the consumer is higher in New York than in Chicago. In New York City, the cost is 25 cents per per 1,000 gallons, whereas in Chicago it is only 7 cents per 1,000 gallons on a meter. In New York City, 143 gallons per capita are used with 28 per cent metered, whereas in Chicago, the supply is 28 per cent metered, but the use is higher.

Universal metering, if inaugurated at present time, would have no appreciable effect in reducing the demand for water from the Chicago water supply system in the next two years. I do not believe that whatever meters may be installed in 1941 and 1942 on the South Side area will appreciably reduce the use of water therein.

LOUIS R. HOWSON, a witness called on behalf of Wisconsin et al.

Direct Examination by Mr. Naujoks.

1935 My name is Louis R. Howson. I am a consulting hydraulic sanitary engineer. I graduated from the University of Wisconsin in 1908 with the degree of Bachelor of Science in Civil Engineering. I am now
1937 a member of the firm of Alvord, Burdick & Howson. I have a general familiarity with the problems of the Sanitary District going back over a considerable period of years. In my opinion one of the influences
1939 to remedy the conditions complained of would be to step up the aeration facilities now available and operate them at their maximum. This would result in a slight lowering of the remaining B.O.D. It would increase the dissolved oxygen in the effluents and would result in the creation of nitrates and nitrites, the oxygen from which would be of value in satisfying the oxygen demand of the channel waters.

Another improvement would be to divert the water which now passes through the water wheels at the Lockport Power House where at the present time very little aeration is accomplished, and diverting it over a properly designed and constructed cascade over the side of the canal into the Des Plaines River, picking up in that way a considerable amount of dissolved oxygen.

A third improvement would be effected if the Brandon Road Pool were dredged for the removal of as much as possible of the sludge now impounded there

and concerning which Mr. Andrew testified. Hydrogen sulphide that reaches the surface and is detected usually comes to the surface accompanied by other gases, and frequently accompanied by disturbance in the sludge depending upon the origin, whether of liquid or sludge origin, of the hydrogen sulphide. A remedial measure may be taken without additional diversion by addition of chemicals to the West Side Imhoff tanks. That might reduce the load from 57 parts per million to 36 parts per million, which is a reduction of some 37 per cent in the amount of B.O.D. going from that plant to the stream.

Another improvement would be effected by passing a maximum amount of West Side effluent through the present South Side facilities.

A reduction in the consumption of domestic water per capita in the Chicago area would cause fewer overflows if there was less of the intercepting sewer capacity utilized by the normal or dry weather flow. If nitrates were present and were continually present, there would be no basis for the present complaints at Lockport and Joliet. Chlorination is a very effective and positive method of controlling odors. I believe its use would be practicable and effective along the Illinois Waterway. The amount of oxygen that could be introduced over cascades would be equivalent to the dissolved oxygen in the summer months of 2500 cubic feet per second, approximately. It would ameliorate conditions now prevailing if the sewage and wastes from adjacent municipalities, industries, etc., were treated. I think it would take from six to nine months to construct sewage disposal facilities for the

municipalities, state institutions, industries, etc. A well receiving seepage from the canal or Brandon Road
1946 Pool, regardless of any amount of diversion, would be unsafe.

1947 I do not know of a condition in Joliet where people are using water from wells for drinking purposes with sewage seepage. If so I would unhesitatingly pronounce them unsafe wells, whether the diversion
1948 was 1500 or 500 cubic feet per second. I don't think
1950 under the presently existing conditions there is a
1951 menace to health. All Chicago drinking water is chlorinated. There would be some slight benefit from chlorination and sterilization of the plant effluents. These remedial or ameliorating measures I have spoken of would afford the same relief that would be afforded
1952 by the addition of 3500 c.f.s. more water from Lake Michigan. Temporary cascades could be constructed near Lockport which would introduce into the water a large amount of dissolved oxygen. The cost would fall somewhere between $50,000 and $100,000 as a maximum.

Cross-Examination by the Master.

1953 I believe that lighter flocculent material which is in that upper zone of 2 or 3 per cent moisture could be
1954 removed by flushing out. A great deal of the lighter material could be moved down by washing down into the Dresden pool below, which is in a largely uninhabited area, and the success of that could be extended
1956 by doing it more than once. No substantial interval would need to elapse between those treatments. The

formation of ice does not interfere with the flow of
1958 water under the diversion from Lake Michigan. The
longer the deposit is there the less potent it becomes,
and the lower layers having been deposited first they
1959 are the least potent and progressively become more
potent as the light flocculent material on top is ap-
proached. Sludge deposit in this stream of more than
a year ago has lost enough of its potency to probably
not be the cause of offense. I am inclined to believe
that more could be accomplished by taking out the
layers recently accumulated than by taking out the
greater bulk of that that has been there for a period
1960 of years. Chlorination of the pool would effect more
positive results per dollar than the expense of re-
moving that million and a half more or less cubic yards
1961 of sludge. I think it would be worth while to draw
out all of that top layer that can be drawn. If any
dredging is done at all you might as well take it all
out. I don't believe it would be feasible to take out
the top layer. If a spill bank or lagoon were used
at a sparsely settled point to dredge out positive ma-
1962 terial would sooner come to an inoffensive state be-
cause the water would be decanted off and go on down
the stream and the solids alone would remain, and
they would soon become liquored sewage sludge di-
gested in so far as they had not previously been di-
gested. It might be possible to put the heavier ma-
terials on top and stuff that has been in there for six
or seven years and practically control the nuisance
as the dredging was done. Reduction in domestic
pumpage by metering would require the installation
1963 of meters in every household. Metering would take

considerable time if you were to meter the whole city.
1965 If you reduce the domestic pumpage while you would reduce the volume passing through the sewage treatment plant you would also reduce the amount of oxygen in that sewage which is now supplied by this water. It would not affect the total pounds of B.O.D. coming to the plant, but instead of being transported in per capita water of 250, it would be, as generally estimated, down around 160 gallons. You would have
1966 fewer gallons of liquid coming through your plant. You would have no economy in air, but you would have more facilities available in your tanks. If you have a smaller amount of sewage but it has to stay in the tank longer you have to offset the smaller quantity against the longer period to some extent.

LOUIS R. HOWSON.

2812 Direct Examination by Mr. Naujoks.

2813 When I stated that there might be a concentration of hydrogen sulphide of 1 per cent more or less in the sewage gas, I had reference not at all to the atmosphere or air above the water, but, rather, to that part of the minute bubble which is coming up through the water, which is hydrogen sulphide. That, of course, is immdeiately dispersed and diluted upon reaching the surface, or such part of it as reaches the surface, without having been dissolved in its passage up through the water. A single bubble or a collection of bubbles could not contain a sufficient concentration of hydro-
2814 gen sulphide to be detected except by detailed analy-

sis. (Opponent's Exhibit No. 8 was offered and received in evidence, being chart showing Use of water
2822 per capita in twenty largest cities in 1940 census). (Opponent's Exhibit No. 9 was offered and received in evidence, being Orders and Reports relative to metering of the Chicago Water Supply).

2825 Exhibit No. 10 was prepared to show in as concise form as possible the alternative methods of adding oxygen or securing additional oxygen for the pre-
2827 vention of complaints from Brandon Road Pool. (Opponent's Exhibit No. 10 was offered and received in
2828 evidence, being Sources of Oxygen for Prevention
2832 of Complaints from Brandon Pool). (Opponent's Exhibit No. 11, was offered and received in evidence, being Means of Reducing B.O.D. Load to Canal to ameliorate or remedy conditions complained of at Brandon't Pool).

2833 Opponent's Exhibit No. 12, entitled "Estimated Cost of Measures to Ameliorate or Remedy Conditions Complained of at Brandon's Pool" was prepared in response to the Master's request that we express in dollars and in time required these various ameliorating measures that have been suggested. The item of cost in "6", I think, is inclusive of the cost of acquiring
2837 a place to dump this material that is extracted by dredging. That would not help much because most of
2838 the more compact solid has lost its potency as a source of trouble. No. 7 on Opponent's Exhibit 12 is flush Brandon Pool to remove active sludge and flocculent material. That could be done at the proper time without the requirement of much time or the expenditure of much money. No. 8 on Opponent's Exhibit 12

covers the diversion of all West Side effluent to the Southwest Aeration Plant, requiring an expenditure of
2839 about 3 million dollars, all of which is a part of the permanent program of the Chicago Sanitary District and which, if it were organized and pushed at once could be done so as to be all or very largely in use by next summer. As an emergency measure, the expenditure of funds, all of which will be permanently useful, No. 8 requiring about 3 million dollars, will produce results as shown on Opponent's Exhibit 11, No. 2; it will reduce the present B.O.D. demand about 200,-
2840 000 pounds per day, or some 40 per cent. No. 9 on Opponent's Exhibit 12 is to cover chlorination of West Side effluent for 150 days, being somewhat comparable to No. 2, chemical treatment. It would cost only $100,000 to install and would cost less to operate. It could be installed in from six to nine months.

The figures of cost given on Opponent's Exhibit No. 12, for No. 9, chlorination of the West Side effluent, Mr. Enslow advises are sufficient to effect a reduction of 15 parts or more in the B.O.D. of the West Side Imhoff tanks. That would be equivalent to approximately 50,000 pounds of B.O.D. removed as compared to the 76,000 shown on Opponent's Exhibit 11 for
2841 chemical precipitation. No. 9 would be preferable to No. 2 because it would do most of what No. 2 would do and cost vastly less. Chlorination measures would
2842 have value after the projects were completed. Chlorinators are provided at the Southwest Side Plant primarily for the control of growths in approximately half of the effluent which goes through the condensers. If the waterway were to be used for water supply

purposes or for recreational facilities, it is common practice to introduce chlorine, or if it were used—if it were in any way a health hazard the chlorination
2843 is the most effective control of that. It is also always available in case of a breakdown of some other process.
2844 No. 9 could be a permanent installation; that is, the dollars cost of installation is sufficient to cover. Item
2845 No. 7 would be changing the location—the location of the sludge; depositing it in Dresden Island Pool which is several times larger than Brandon Pool and which is in a very sparsely settled area. (Opponent's Exhibit No. 12 was offered and received in evidence, being Estimated cost of measures to alleviate or remedy conditions complained of at Brandon's Pool).

Direct Examination by Mr. Naujoks.

2848 It is not a universal practice to chlorinate water with which dairy cattle come in contact. It occasionally becomes necessary to by-pass sewage. A chlorinator is a very valuable shock-absorber and insures against breakdowns. In connection with flushing the Brandon Road Pool I believe more would be
2852 accomplished with the same volume of water. Opponent's Exhibit No. 13 was offered and received in evidence, being Sources of B.O.D. and B.O.D. of Canal at Lockport.)

2854 Examination by the Master.

2855 For the last four or five months of 1939 and the first three months of 1940, all of the Southwest Side Plant was functioning, so that during that time they

were doing a more complete job than they were taking this particular month, and I think that that meant that there was less material, from, say September last year to April this year. The Sanitary District in July
2860 1940 were doing a 20 per cent better job than they did in June 1939. I think that the B.O.D. at Lockport in 1941 won't be over somewhere around a third as much as it was in 1940.

2862 Direct Examination by Mr. Naujoks.

Chlorination of the Imhoff tank effluent would reduce the B.O.D. going to the Canal. If that be taken at 15 parts per million, it would effect a reduction of about 45,000 pounds, making 169,000 pounds, about 124,000 pounds. That chlorination of the West Side effluent would be reflected by 15/21 of the Item No. 1 on Exhibit No. 11. Item No. 1 on Exhibit 11 ties up with item 9 on Exhibit 12. I am undertaking to give the court a picture of what the situation is going to be in the summer of 1941.

2865 Cross-Examination by Mr. Clausen.

Referring to Item 9, the cost of $100,000 I figured on a building which would be a summer-operated building. I have not made any detailed plans. It in-
2866 cludes chlorinators, evaporators, piping and a structure. I figure about $5,000 per ton of daily capacity. I think no storage capacity is required for chlorination. The building would be a steel building, light

construction, with some type like transite slab side-
2867 walls. The life of the building is a question of main-
2868 tenance. If properly maintained it would be good for anywhere from 15 to 25 years.

2870 When I refer on Exhibit No. 12, to the approximate annual operating cost of chlorination of Canal water, No. 3, as 70,000 to 300,000, that relates to Item 5, Exhibit No. 11, as chlorination producing 6 parts per million of chlorine.

October 17, 1941

LOUIS R. HOWSON (Cross-Examination).

3217 Referring to Exhibit No. 12 of my testimony, item 3: If I were to assume that the chlorine used were a maximum of 12 parts per million continuously, the annual operating cost would be one-third more than $300,000 figured on 9 parts per million continuous, or $400,000. That is continuous, over, I believe, a hundred day period.

3218 Exhibit 10, under item 2 where I refer to the North Side and Calumet Plants, 370 million gallons daily, that is an error. It should be 270 million gallons daily —200 million gallons daily for the North side and 70 million gallons for the Calumet. At 270 the pounds of oxygen would be about 40,500 pounds instead of 55,000.

In item 3 under Exhibit 10 the figure of 6-3/4 parts per million of oxygen pick-up is based upon two principal sources of data. One, the observation of re-aeration over the Hastings Dam in the Mississippi River,

where the water in going over the dam consistently carried about 7 to 7-1/2 parts per million, and, secondly, it is based upon experience at the North Side Plant in the effluent channel of the Chicago Sanitary
3219 District as reported by Mr. L. C. Whitemore, designing engineer for the District in Sewage Works Journal in, I believe, about May 1937. In that issue he stated that it was consistently practicable to pick up oxygen in the amount of 85 per cent of saturation and comparing that with five years' records of the North Side Plant, which are in evidence in this case, the average pick-up in that outfall, which was a happenstance rather than a matter of design, has averaged 6.7 parts per million.

3219 I think that is about right, that the North Side effluent has only 1.5 parts per million of oxygen before it goes over the aerator, as of 1939, but as it goes to the canal after going over the cascade—or not a cascade—just simply the aeration it picks up in the conduit during the year 1939 averaged 8.7. The pick-up average during that year was 6.5 parts per million.

3220 The B.O.D. in the effluent during 1939 was also 7.7 parts per million. Exhibit No. 12 under item 9, I expected to get a reduction in B.O.D. from chlorination of the effluent for 150 days. I testified that it would probably be about 15 parts per million, equivalent to approximately 50,000 pounds of B.O.D. per day. This was omitted from Exhibit 10 because Exhibit 10 is sources of oxygen. I don't call chlorination for the reduction of B.O.D. the production of dissolved oxygen or an oxygen source.

B.O.D. is stated as so many parts per million, that
3221 is, one part per million would be one pound per mlilion gallons. To convert parts per million into pounds with respect to water, we multiply by the weight of water, which is 8.34 pounds per gallon. So that in pounds per million gallons is 8.34 times parts per million.

I think the reason it was omitted from Exhibit 11 is that it was put on after Exhibit 11 was prepared. It is comparable in its effect to No. 1 on Exhibit 11, only 15 parts per million instead of 21 as shown in No. 1. It is an ameliorating effect of the same type. It is one form of chemical treatment in reducing B.O.D. The relationship between item 9 on Exhibit 12 and item 5 on Exhibit 11 is—Item 5 on Exhibit 11 is chlorination of the entire canal flow and corresponds to item 3 on Exhibit 12. Item 9 on Exhibit 12 refers only to the effluent of the West Side Plant.

3222 There is no figure for the chlorination of Brandon Pool alone except that Mr. Enslow's lower figure —the figure comparable to the $70,000 under 3 on Opponent's Exhibit 12,—as I recall his testimony, would be sufficient for one point chlorination at Brandon Pool. I can't tell you how much chlorine I expected to apply to the West Side effluent in parts per million under item 9 Exhibit No. 12. That figure was taken from Mr. Enslow's testimony and I don't presently recall it. I think he testified $691 per day, is my recollection of his testimony.

I think the various times required shown in Exhibit 12 are ample if work was started immediately, starting from its present status with plans in preparation

and expedited to the full extent that is justified if a health condition is thought to exist. Some of them have already been started. I think all of them ought to be going right now, the ones that are going to be built.

3223 Assuming that they haven't started, bearing in mind that it is the Sanitary District of Chicago who has to advertise for bids and so forth, I would say that the times I have put there are practicable of accomplishment providing it is pushed as rapidly as practicable and I am basing that upon my experience in handling municipal contracts which constitutes some 75 per cent of my work. All public works requires bidding, in preparation of complete plans and specifications and the advertising of the work and it takes time for drawing plans and specifications too. Take No. 4 which has 3 to 6 months on it. If that job were assigned to my office under municipal requirements of
3224 advertising for bids, but assuming, on the other hand, that all expedition would be exercised, I am quite sure that the outside period of 6 months would be adequate to have it in operation. I mean to draw all the plans, make the design, call for bids, let the contracts, complete the work.

I can't say whether it would be necessary to secure the approval of the War Department, but in view of the fact that it does not affect navigation, as I see it, it seems to me that there ought not to be much difficulty. The flow is going to be there for lockage just as it is now. I think, however, that on all work in connection with navigable waterways a permit of some kind would be required, but my experience is that

there has not been very much time required to get permits where it is really gone after. With what I contemplate there would be no structure within the channel lines of the Sanitary District Canal.

3225 I can't answer positively whether or not there would be necessity for seeking a permit from the War Department on this item 4. I think there would have to be a permit probably. The first thing I would do would be to ascertain whether I needed one and then I would go after getting it. I have secured permits from Army Engineers in many, many jobs, and I know that it does not take a great deal of time. Only in certain things would they have to have public hearings—in case there are objections and controversies. In

3226 most cases a permit, where you do not get inside the harbor line or navigation line that has been established, is a comparatively simple matter. I can't see where this would affect any industry. It doesn't lower any water level in the canal. It is the same as it is today. I did not inquire from the government whether or not they would issue a permit without a hearing in that connection and I am not sure whether or not they would require a public hearing before they would issue the permit. I am simply basing it on prior experience in dealing with governmental agencies. If they were to require a public hearing it is indefinite as to how long it would take. In general then I would say that in all the applications I have made to the government engineers for a permit there has not one of them yet gone to a protest hearing.

3227 I still say it is indefinite as to how long a hearing would take if it did go to a hearing. It is entirely a

question as to whether one or more hearings and how much opposition there is to it. It might be more than 30, it might even be more than 60 (days) depending upon the extent of opposition developed. I simply state that in all the applications I have made to date we have never gone through a protest hearing.

3228 I think the sludge deposits in the main channel above the power house have been there for a long time. Yes, in my opinion, such deposit does exert a demand for oxygen—the extent of the demand depending upon their condition. Such deposits would exert more demand in the summer than in the winter time —the higher the temperature, the more active the demand. The sludge deposited in the main channel above Lockport Power House is an additional source

3229 of B.O.D., but I have yet to see anybody that has found any very definite way of evaluating it. It is not included in the figures in Exhibits 11 and 13 except as reflected in the B.O.D. of Brandon Pool, which represents the B.O.D. picked up by flowing over these same solids before getting into Brandon Pool. To that extent it is reflected in the sum total.

In determining the B.O.D. of Brandon Pool in Exhibit 11, that is based upon other testimony in this record. It is based upon, I believe, an exhibit put in by Dr. Mohlman showing the B.O.D. of Brandon Pool and it is based upon an average annual flow of 3130 cubic feet per second. Brandon Pool as used in these figures extends from Lockport power house to the Brandon dam.

3230 Item 6 of Exhibit 13 has no significance, and you will notice on Opponent's Exhibit 14 I say "This line of

Opponent's Exhibit 13 omitted as of no significance". It was a figure that was in my original work sheets and was copied over. It has no significance. The column under 1941 in Exhibit No. 14, in my opinion, means that by the summer of 1941 everything can be cleaned up, so far as treatment is concerned, with the exception of the treating of the effluent at the West Side Plant and, as shown on Exhibit 11 or Exhibit 12, I personally believe that by pushing that work that too can be completed. Certainly I believe the West Side final treatment construction can be completed very practicably by the summer of 1942.

3231 No, I don't think there should be an increase shown in the column 1942 for the item under "F" reading for 1941 169,000. That is the West Side effluent. I think by the summer of 1942 activated treatment can be applied to that waste and produce an effluent which will be in oxygen balance. That is the same thing which I understand the District plans to do by the end of 1942.

The only difference between me and the District is that they say it will not be finished until the end of '42 and I say it is entirely practicable to finish it to be effective during the summer of 1942, and it is my contention, as indicated by Exhibit 14, that with diligence there should be no excessive B.O.D. over D.O. in this situation after the summer of 1941; certainly not in the summer of 1942.

3232 Yes, my firm was employed by the United States Government to install sewage treatment at the Great Lakes Naval Training Station during the World War. We designed there what we call a winter aerator—

a cascade to aerate the effluent from separate digestion tanks handling the station sewage. Speaking from recollection, I think it operated a month or two. I think I had something to do with not operating that aerator. That was put in before the Great Lakes construction was expanded. At the time that plant was started there were about 4,000 men at Great Lakes and by the time we finished, as I recall it, there were over 60,000. They built a hospital about the time this plant was built within three to five hundred feet of that winter aerator, and the aerator was only operated for a short time because of the fact that construction had been built so close to it.

3233 It didn't create so much of a nuisance. It was not the proper construction to operate within 500 feet of a hospital. There was odor and steam. The temperature of the Great Lakes sewage was very high. It was a non-return heating system, and in the cold weather, the colder the weather the hotter the sewage, and the sewage, as I recall it, was as hot as 95 degrees Fahrenheit, and in cascading, steam was created and it was shut down. I recommended that it be shut down as not being applicable construction to the locality and, further, by that time we had put in our final settling or coagulating basis and our sand filters. I said that it was shut down because of the hospital being built immediately adjacent to this plant and located about 50 to 60 feet above it in elevation.

3234 The hospital was located after the treatment plant. I think if the hospital had been there when the plant was built I would have done several things about that plant that was not done then. I think I would have

done what I later did in the same plant, closed in the conduits. I would have done that simply for the reason that when we found our sewage was 95 degrees temperature, we didn't want it steaming. I wouldn't run undiluted or untreated sewage right past a hospital, especially if it was hot and steamy. I think there are better places to run it.

3235 I think the impression here, possibly from the questions, is that the cascade was originally designed to be operated continuously. As a matter of fact there were two pipes leading from the tanks and the cascade, and it was never planned to operate the cascade continuously. There was a rapid sand filter built as the finishing process for the plant and the sewage that came to that rapid sand filter came to it either through pipes or the cascade. That was cascading of straight sewage.

3236 I think that is entirely different from what is suggested here—the cascading of water. The purpose, so far as the picking up of a little oxygen is concerned, is the same, but the main purpose of the cascade up there—we had, I think, some 40 feet of waste head. Our tank was built on the top of a knoll and our plant was built at the bottom, and I put in that cascade to utilize that head to pick up what oxygen I could on the way down. This rapid sand filter continued to operate for a great many years and satisfactorily. It is not a fact that it plugged up rather quickly. It operated for 15 years.

3237 The only case of plugging on it was when it was washed backwards once with dirty wash water containing matches in it—that plugged openings in the

pipe. Aside from that, it operated 15 years satisfactorily. No, I don't think it is so that the wash water from the filter was impounded behind a break water. I think the wash water went to a storage tank and was repumped back through the plant again as sewage. I am quite sure that is the case. It went into a holding tank from which it was repumped to the plant and went through again as sewage. To my knowledge chlorine was never recommended to ameliorate the nuisance caused by the combination of cascade and the filter. The effluent of that plant was chlorinated for sterilization purposes because it went back into the lake from which the water supply was taken about a
3238 half mile or mile distant. To my knowledge it was not chlorinated to ameliorate any nuisance that was caused by it. If so, it was after the war.

In my testimony on page 1939 I referred to cascades and stated that such a device would pick up a considerable amount of dissolved oxygen. My estimate of what it would pick up, as stated a few minutes ago, was based upon the records of the Sanitary District here in the North Side outfall and on the Hastings Dam. Behind the Hastings Dam there was a lot of sludge. All of the South St. Paul packing plants, the Newport Minnesota Packing Plant of Cudahy Company and all of the untreated sewage of St. Paul and Minneapolis went in behind Hastings Dam. I can't tell you from memory what was the B.O.D.

(By Mr. Clausen) I think Mr. Warrick testified it
3239 was below 7—around 7. That was the average as I understand it.

(By Mr. Howson) If that was the average, it doesn't conform with the peak in B.O.D. in Hastings Pool. I don't think it makes so much difference. It was practically devoid of oxygen and the amount it picked up isn't so much a question of B.O.D. as it is of oxygen deficiency. I have never personally run any tests on air picked up by sewage passing over a dam. Yes, I think you would get dissolved oxygen into such water as at Lockport by cascades where the B.O.D. may be 30 or 40 parts per million and the dissolved oxygen zero and the water necessarily very septic. I don't think it would disappear almost at once because there is below the gates at which I would contemplate adding this aeration a two and one-half mile turbulent stretch in which there is over 15 feet fall comparable
3240 in that respect to the conditions that formerly prevailed through Joliet itself before the construction of Brandon Road Dam, and through that reach they used to pick up about 400,000 pounds of oxygen per day, partly dissolved oxygen and partly through satisfaction of B.O.D. That is reported officially in Part No. 3 of the Sanitary District Board of Review, a report prepared about 1925 by 38 engineers employed by the Chicago Sanitary District. Yes, I said it was turbulent. Now, no. That was before the dam was built. There was a turbulent section there. Now there is a turbulent section in the Des Plaines River extending from the power house northerly to the Stony Gates where I would figure on cascading.

3241 The distance is about two and one-half miles. The firm of Alvord, Burdick & Howson has designed and built three, I think; maybe more, activated sludge plants.

They are at Gary, Indiana, just recently completed; West Dundee, Illinois; Elmhurst, Illinois. I would have to guess at the population of West Dundee—maybe 3000. Elmhurst serves about 21,000, at least that is the basis of the design. It may be somewhat less than
3242 that now, but it is not far from that. Gary is a 40 million gallon plant, designed for 170,000. It is among the ten largest in the country. Gary is the largest activated sludge plant the firm has built. I would say that a 5 million gallon plant at Elmhurst is a moderate size plant. Elmhurst was built first. The processes of sewage treatment investigated were the trickling filters, the Guggenheim process, which is a chemical precipitation aeration process, activated sludge and trickling filters combined with chemical precipitation. That was at Gary. We recommended the activated sludge process.

3243 I recommended it because it produced the best effluent and a large part of that effluent discharged back into Lake Michigan from which the water supplies of the Calumet area as well as Chicago are received. It was about intermediate, as I recall it, of the four processes in cost of construction, and intermediate, I think, as well in annual cost. It was chosen primarily because of its high quality of effluent. I did not include at Gary the installation of chlorinators. I put in a very complete treatment at Gary and the effluent discharges into the Grand Calumet River which receives the pickling liquors from the sheet mill at Gary in the amount of 3-1/4 million gallons a day, which is then diluted to about 10 to 1 and is a sterile waste. That is, it discharges into a stream that is prac-

tically a pickling stream. Our firm has advised on activated sludge plants. We are not operators.

3244 Personally I have never operated an activated sludge plant. I couldn't tell you from memory what, in my sewage works practice, is the largest dose of chlorine per day I have had occasion to plan for. The Racine (Wisconsin) plant is designed for an average flow of 12 million gallons a day but has taken storm flows, chlorinated, in, I think, to 55 million gallons a day through the plant. As to pounds of chlorine I can't tell you what that installation is. I would have to look it up, but it is an installation that will feed a small tonnage per day. I think that is the largest sewage chlorinating plant we have put in probably. Yes, the sewage plant at Gary is in complete operation. The garbage grinding end of that plant is not yet started. That went into operation about the 1st of September (1940).

3245 A part of the effluent from that plant goes into the water supply of Chicago through the Calumet, the Grand Calumet River, and part of it then by-passes out through the Indiana Harbor ship channels of the lake. Assuming the East Chicago Ship Canal is blocked and flow cut off from the steel mills to the lake, I don't believe chlorination of the Gary effluent would ameliorate conditions in Brandon Road Pool. I don't believe you would ever find it, bearing in mind that that discharges into and immediately adjoining the pickling liquor wastes of the steel company. I don't think the additional pollution from the Gary plant is a load on the disposal system of the Sanitary District. I don't think there is any measurable or ap-

preciable amount gets into the Chicago Sanitary Dis-
3246 trict channels, very small, at least. The meetings of the governors and the attorney generals for a number of years has been more with respect to other cities' wastes than Gary. Gary differs from other Calumet cities in its point of discharge of its wastes. I know there have been conferences but I don't know what Gary has admitted about causing this pollution.

The effluent of the new Gary system will be the same as the completed program of the Chicago Sanitary District. It is just started now six weeks—full operating data is not yet available—but it is designed to produce an effluent having a B.O.D. of less than 10 and a stable effluent in oxygen balance. It is designed to produce
3247 the same result as the completed program of the Chicago Sanitary District is designed to produce.

When I testified on direct that equipment for chemical treatment could be obtained before the summer of 1941, I meant that a temporary installation could be made by that time. I do not mean that the permanent chemical head house, chemical feeding such as would be used if chemical precipitation were the only form of treatment to be put in at the West Side, would be constructed. That was a temporary installation. If the Gary Plant does what it is designed to do, we expect the purification to be between 90 and 95 per cent.
3248 I believe our firm was first employed as engineers for Joliet on sewage treatment in the summer of '38. It might have been '37. We made our report in three or four months from that time. We recommended a plant to be located at the mouth of Hickory Creek which flows into the Illinois Waterway at Brandon

Road Dam, the plant to consist of separate sludge digestion type of tanks followed by trickling filters and secondary sedimentation. The Joliet problem is status quo until the Chicago problem is cleaned up. By "Chicago problem", I mean until the condition of the canal, the Illinois Waterway, is cleaned up. I think Joliet feels that an investment by it should be deferred, although the City Council, or the City of Joliet, did make application to the Federal Works Administration in, I believe, 1938, for an allotment to proceed promptly with the construction.

3249 I think the suggestion they should wait to take in the area which they would eventually have to take in also had something to do with it. Joliet's boundaries were restricted to something like 45,000 people in Joliet and another 30,000 immediately outside. We think all ought to be in one plant. They have taken in some of that territory and the matter of getting additional territory is one of the problems they are confronted with. The mayor did talk to me and told me he was taking all the steps they could to get these boundaries extended so as to serve the entire district instead of just the heart of it, and I think that has some bearing upon just when they proceed. They put in an application and intended to go ahead in '38 had they received an allotment. They didn't receive the allotment.

3250 I think all three circumstances influenced their waiting somewhat, because all three were discussed in the conferences I had. Had they gotten an allotment under the PWA, I think they would have gone

ahead without waiting for either annexation or the Sanitary District to complete its program.

3251 In sludge as withdrawn to drying beds we usually find a moisture content of 88 to 92 per cent. It might run as high as 90 to 95 per cent depending upon plant conditions and other factors, but our experience has been mainly 90-plus or minus. I would expect to find more than 2 to 5 per cent of solids and 90 per cent of water. I would not expect in a sludge digestion tank to have a moisture content as low as 70 per cent. Such a sludge couldn't flow—it would require a steep-pitched flow. In proper operation the ebulli-

3252 tion of gas is continuous in a sludge digestion chamber. If the effluent of an activated sludge plant contains dissolved oxygen to the saturation point, an increase of air in the aeration tanks won't add any dissolved oxygen. It may add nitrates and nitrites. I have never personally run any tests on the air picked up by sewage or polluted water passing over a dam or cascade. Assuming the double of the amount of air at the North Side Works, it would reduce the present B.O.D. in Brandon Road Pool some 24 hundred thousand pounds—the oxygen added by the additional nitrates and nitrites would be some 40,000 pounds, about 10 per cent. In a general way I know the conditions in the North Shore Channel.

3253 As a measure to be adopted to ameliorate conditions within the next year or two, the installation of a 100 per cent metering for Chicago domestic water supply wouldn't be practicable of accomplishment in one year. I am advocating meters. I have advocated metering of Chicago's water supply for 20 years. I

don't think that to ameliorate you have to get 100 per cent done in a year. I think you ameliorate to just the extent that you get it done. I think it would be practicable to put in 30 to 50,000 meters in one year's time, and that would have a very appreciable effect in reducing the flow. Yes, our firm has advocated to the City of Chicago the use of meters on the Chicago water supply.

3254 The first report on that I had anything to do with was in 1915—25 years ago. We have made a good many of them since. Yes, our firm recommended meters in the report made to the District Engineer in 1925.

The reduction of domestic pumpage is not an item appearing on any of these exhibits 10 to 14. It appears only on the blueprints and the blueprint showing comparative water use in different cities. It isn't noted in my exhibit 11 as a means of ameliorating conditions. I couldn't tell you without reference to the report what I reported to the U. S. Engineer in 1925

3255 in regard to the value of 3500 c.f.s. diversion. I don't think 3500 second feet was put up to us. I don't think we reported anything on 3500 second feet. I am quite sure we didn't. We reported upon the fair and reasonable costs of sewage treatment requirements of Chicago with varying rates of diversion from 2,000, 4167, 8500 and 10,000 second feet, is my recollection. Possibly there was another one in there at 6,000. That was based upon conditions in the canal given to us. The conditions stated to us were that, so as to result in conditions in the Illinois Waterway which would restore and promote a thriving fish life, which is much

more rigid than a nuisance requirement, because it takes about two and one-half to three and one-half parts per million of dissolved oxygen at all times to support fish life, whereas, with nuisance, to avoid
3256 nuisance, simply requires slight dissolved oxygen or even nitrate and nitrite oxygen. In an oxygen balance the dissolved oxygen should equal the B.O.D.

(The Master) I might break in here to say that I have just been informally advised by the Chicago Office of the U.S. Engineers, whose observer is present at all these hearings and is present now, that approximately 14 days would be required for the handling of a permit for the cascading unit near Lockport described by Mr. Howson. This includes the minimum period relative to issuance of a public notice. No public hearing would be necessary. No opposition is anticipated. I am further informed by the U.S. Engineers that this, in their opinion, would not involve any delay of carrying out the suggestion of Mr. Howson, because he could submit his plan and they would go through their routine and the plans for the work could be proceeded with without delay.

(Mr. Howson) I prepared and read a paper at Milwaukee, Wisconsin on sewage treatment last spring (1940).

3257 That looks like a copy of the paper although I hadn't seen it in print.

Q. "I wish you would read to the Master the paragraph at the bottom of page 37 in which you mention a number of plants using chlorine.

A. "Chlorine is being increasingly used for a wide range of purposes, including grease flotation,

sterilization, prevention of filter bed clogging, septicity, and so forth. About 700 plants now use it for some purpose."

I think there are approximately 3000 sewage plants in the United States. I see on page 32 of my paper I say approximately 3500. That was in 1935. Since that year, up to this year (1940) there has been about 700 new plants built. I say here: "696 were reported up to February 1940" a total of about 4200.

3258 Q. "Now, would you also refer to pages 40 and 41 of the article and read to the Master the portion that is marked?

A. "A marked trend in the operation of activated sludge plants which is now being reflected in construction and design is that formerly excessive amounts of air were used, even dilute sewages being given as much as 1 cubic foot of air per gallon. Following the lead of the North Side plant in Chicago where, with a 5-day B.O.D. averaging slightly over 100 parts per million, the air requirements have been reduced progressively from about 1 cubic foot per gallon to approximately .35 cubic feet per gallon; other plants having similarly reduced their air requirements. Whereas, formerly plants operated so as to carry a large dissolved oxygen content in the effluent, it is now generally considered economically desirable to operate with a dissolved oxygen of but one to two parts in the effluent."

Redirect Examination.

3259 Yes, I think that oxygen efficiency is the most important factor in obtaining oxygen through reaeration over cascades. That and also the question of head available for it.

I think the opinion expressed in this article with reference to the amount of air in use by operators of activated sludge plants, and the opinion I expressed here in this case as to the use of increased air as a temporary ameliorating measure to obtain additional dissolved oxygen or nitrates and nitrites in the effluent is entirely consistent. As the quotation states, it is generally considered economically desirable to use as low quantities of air as will maintain 1 to 2 parts of dissolved oxygen in the effluent. That is the economy of the thing. When it comes to a question of health
3260 or remedial measures to alleviate conditions said to result in detriment to health, I think the economy can well be outweighed by the desirability and the beneficial results that will be secured from nitrates and nitrites.

Examination by the Master.

The word "present" opposite dissolved oxygen in Exhibit 14, item 5, under columns 1941 and 1942 means that there would be some dissolved oxygen present that I did not undertake to measure the extent of. I think there would be dissolved oxygent present at all times which would mean that hydrogen sulphide would not be given off, and in view of its being present and

the difficulty of saying exactly how much there would be, I thought it was sufficient to indicate and better to indicate by "present" than by parts per million. Now in the balance condition that I speak of the B.O.D. would be balanced by the dissolved oxygen. There is some B.O.D. even in our natural watercourses that haven't sewage pollution from other organic sources, so that in the last column, 1942, B.O.D. in Lockport, pounds per 24 hours, I put 100,000 pounds
3261 plus or minus, which is about 5 parts per million of B.O.D. and that isn't arbitrarily taken. It is taken from a study of the figures in line 4 and in the bottom line of column 1938 '39 and '40. For illustration, the principal sources in 1938 contributed 645,000. The B.O.D. as measured in Lockport was 627,000. In other words, enroute to Lockport the dissolved oxygen in the lake water of 220,000 pounds had been used up in the process, in the travel, and similarly in the next year, 539,400 from the sources, 558 at Lockport, and in 1940, 421,000 as compared to 389. Well, from a comparison of those figures I am quite sure that next year, 1941, at Lockport and, incidentally, from the figures I have received from the district for August operation, the discharge of sludge to the canal has practically ceased. Only, I believe, 315 tons in the month of August, which is nominal. So that I am quite sure that the 150,000 pounds of B.O.D. for 1941 is liberal, and that it will progressively go down to 100,-000 or below. In a 90 degree purification the B.O.D. would be about on an average of Chicago sewage—10 or 11 in the effluent.

3262 If that B.O.D. was balanced at only 90 per cent it would take 11 parts of dissolved oxygen, which is higher. That corresponds to the B.O.D. but of course, that is higher than they could get the year around. Their operating results show the ability to get 8 or thereabouts, out of that 11, but on the other hand, their operating statistics show their ability to get better than 90 per cent treatment, and to get an effluent; for illustration, for the last three years the North Side plant has been in complete balance, an excess of available oxygen in the effluent. I think that is practicable with the others as well. These conditions at Lockport, I think would be indicative of conditions at Brandon Road Pool.

3263 If Brandon Road pool were not drained or the accumulations there were not removed, then the conditions in Brandon Road Pool would not be as favorable as at Lockport, to whatever extent there was B.O.D. absorption from that sludge. However, if there is no new sludge put in from now on which is, say, September until next summer, the effect of the sludge previously put in is going to be very materially reduced.

Recross-Examination.

On Exhibit 11, "1" and "2" are not comparable with No. 5. They are all ameliorating. They are a different type of amelioration. They are either alternates or
3264 possible measures, all of which might be put into operation simultaneously. I indicate various combinations at the bottom.

Yes, as I understand it, No. 2, 3 and 4 are in the Sanitary District program. I don't think No. 3 is in anybody's program. I think No. 3 ought to be done right now. Somebody testified they proposed to do it after the first of the year, but they hadn't commenced
3265 to do it after the first of September. The statement in your petition that you contemplate having your work completed December 31, 1942 doesn't refer to No. 3. If I gave the impression that you would have all of your program completed right now, that wasn't what I meant. What I meant was that No. 3, which is simply by-passing after primary treatment, I don't think you have to wait for; you can do it now. I don't think anybody has testified exactly as to when that was going to be done. It can be done now.
3266 In my judgment item 3 could be done right away. With respect to item 4 that is substantially being accomplished now. The last figures I got there was only 315 tons of sludge, I believe, discharged to the canal during the month of August and that is between 5 and 10 per cent of the total, so that No. 4 is pretty well cleaned up at this date, maybe wholly for all I know.

In "5" I have the same amount as in No. 2. It just happens to figure that way, both about the same. No, I haven't said I think chlorination is equivalent to
3267 activated sludge treatment. You are chlorinating and activating different things. You are activating only a West Side effluent and you are chlorinating 3,000 cubic feet a second; entirely different things. In pounds of B.O.D. removed they happen to give practically the same pounds. It is about as much alike as apples and

oranges may be the same size but they are not the same fruit. I don't think you would probably do both "2" and "5". "2" according to the District program takes two and a half years to do, "5" gives the same amount of pounds of B.O.D. removal and can be effected, I believe, before next summer. If someone thinks a health hazard exists that is one way of ameliorating it. I think if it went full speed ahead right now without waiting until a decision comes out, but simply push right ahead now, I think "2" could be done by next summer. There is only about 4 million dollars or 3 million dollars involved. Theoretically,
3268 if money were no object I could do both 2 and 5 as rapidly as possible. If 2 were done, 5 wouldn't be as effective, because a lot of that B.O.D. would have been removed by activation and there wouldn't be as much left to take out with chlorine, so you couldn't really add them up together. I think the pounds of B.O.D. removed from the canal in its present condition by chlorination would be the same as pounds of B.O.D. removed from the West Side plant effluent by activation. So far as the economics of the thing, I don't think they are in the same position. As I pointed out under 5 chlorine would be applied to 3,000 cubic
3269 feet a second which is 2100 million gallons a day, where activation of the West Side only takes about 400 million gallons a day—about 5 to 1.

I am not recommending here chlorine in place of activated sludge treatment. I think the District engineers are right in making complete activated sludge plants and it should be done just as quickly as possible. I think we have been in accord on that general

policy for a good many years. As a matter of fact, I think the Lake States' witnesses testified to activated sludge even before the District adopted the program.

3270 I think 500 feet is about the distance the hospital at Great Lakes Training Station was subsequently built from the cascade about which I testified previously. The sewage passed into a settling tank and then went over the cascade. I said that in cascading that warm sewage down over the steps, steam, or a moist vapor, a fog, resulted. I don't know that it was carried to the hospital. I don't think it was, but there was a general fog around that area. I did recommend stopping of this cascade. We didn't need it in the process when we got everything finished up. We were not interested in dissolved oxygen in that plant after we got filters and then discharged it into the lake where there was an abundance of dissolved oxygen.

3271 You correctly understood my testimony in which I stated that the close proximity of the hospital was one of the factors which influenced me in recommending that this cascade in this project be stopped. I wouldn't run raw sewage or settled sewage in an open conduit or in an open canal past a hospital. I would put it in the pipes that were already provided for it. I don't think it is good engineering practice to flow raw sewage in any open place, and that was in the nature not only of an open conduit, it was in the nature of an open conduit with a bunch of steps in it. It was more than an open conduit because its very construction was conducive to spray and fog. The medical authorities at the Great Lakes Naval Train-

ing Station did not consult with me with reference to the cascade. The construction such as at Great Lakes and under the conditions there operated was conducive to spray and fog.

3272 The spray and fog is simply somewhat more objectionable because it is broken up. It accentuates the objectionable features of raw sewage flowing in open conduits through inhabited, densely inhabited areas. Some of those objections are esthetic; I think most of them are esthetic, as a matter of fact, except as affected by possibly, use or contact. We don't build open sewers through cities any more. We put them underground. There may be a health standpoint there, depending upon the use and the availability to contact.

Redirect Examination.

3273 The time for completion of the aeration plant, final settling tank, all of which is part of the permanent program, shown in my exhibit 12, item 8, was based upon a consideration of what is practicable to do when something has to really be done. An extreme illustration, during the former World War we were on five large construction jobs, cantonments, pickling acid plants, things of that kind. In those it was necessary to build six to eight million dollar constructions in 90 day periods. We are just now starting another cantonment, estimated cost about nine million dollars. That is under contract to be completed in four months' time; and we are also working on water supplies for powder plants which are emergency jobs. Those jobs

are the extreme illustrations of what can be done in necessity.

3274 The cost of construction of the Gary plant was about two million dollars. From the time we started until it was completed and placed in operation the total time was approximately a year and a half. As I recall it, we were instructed to proceed with the plans in the very early spring or late winter of '39 and the plant went into active operation about the first of September in '40.

Q. (By Mr. Clausen) How long in advance of that before the plans were prepared.

A. The first date was the date on which we were instructed to proceed with the plant.

Q. What preliminary work was done prior to that.

A. Well, we had made plans for sewage treatment at Gary once in 1928, and the depression came on and it was never built. Those plans were completely junked even to the extent of going to a new site. That was a trickling filter plant.

None of those plans were used.

3275 When did we make the investigation? We made a report I would say, from memory, November or December 1938. It took from the time we first started to study it to 1940 to complete the job, which isn't the case with the Chicago Sanitary District, because they know what their program is. We spent a total of some 20 months at Gary from the time we started this study
3276 to the time the plant went in operation. That included all the time that was put on that project from

the time of our preliminary investigation until the time it went into operation.

January 16, 1941

L. R. HOWSON (Recalled).

Direct Examination by Mr. Naujoks.

3873 I have made an examination of Mohlman Exhibit No. 17, a report on the flushing experiment for the period from December 2d to December 12, 1940. I have made some analyses of the data therein in order to have an opinion as to the matters about which you now ask me. The time allotted—the time available
3874 —has not been as ample as I would have liked but it has been sufficient to have enabled me to arrive at the conclusions which I now state.

I believe the flushing experiment has been of permanent good throughout the entire length of the waterway from the upper end to Brandon Road Dam, including, in my opinion, the pool itself. There has been some 80,000 tons of solids picked up, and that is suspended solids, of which approximately 21,000 has been washed through the pool and Brandon Road Dam. Those solids that have gone through the dam will not again effect any leaching effect on the oxygen sources of the canal. Before this flushing test there was this 80,000 tons pretty well distributed in the canal itself above Lockport. At least 73,000 tons of it came from there. If there was 6 inches taken out over the reach of the canal from Lockport to the West Side Plant it would account for 84,000 tons.

3875 Solids of a putrescible nature that are deposited in a channel, such as the main drainage channel, exert a leaching effect on the oxygen in the water. Now if those solids were uniformly distributed, or of the nature of the distribution from the West Side plant to Lockport, there would be a cumulative leaching effect, and that would have continued through the Brandon Road Pool and that continuing or cumulative leaching effect would have been due to that 84,000 tons. Now the cumulative leaching will be only that due to 63,000 tons, of which the very great proportion will take place in Brandon Road Pool itself.

In order to visualize this I have prepared a diagram.

(Said diagram entitled "Sketch illustrating effect of flushing test on B.O.D. of Brandon Pool, Based on Suspended Solids Carried Out" was offered in evidence and marked "Howson Exhibit 1")

3877 There are two lines on this diagram. The upper line shows at the West Side Plant zero of the solids later carried out which, according to Mr. Mohlman's evidence, accumulate to about 73,000 tons at Lockport and 84,000 tons at Cass Street or the Dam. That curve, the upper curve of Howson Exhibit 1 from point "A" to point "B" illustrates the probable approximate depletion of oxygen due to the suspended solids that were removed or that were moved in this flushing experiment. The lower curve, designated from point "A" to point "C", is illustrative of the conditions after flushing, by which the oxygen depletion affected by the sludge

remaining in the canal is much reduced in the stretch of the first 25 miles extending from the West Side Plant to Lockport, and then rises sharply to point "C" because of the fact that there has been a large volume of sludge deposited in the last 5 miles, which includes Brandon Road Pool. The total cumulative effect, however, from
3878 the West Side Plant to Brandon Road must, in my opinion, always be less than if the experiment had not been conducted, in the ratio of 62,000 to 84,000 tons of solids. The cumulative effect of the oxygen leaching due to the solids will always be less in the ratio of 62887 tons of solids left in Brandon Pool as compared to the 84,000 that originally were drawing out oxygen; in other words, something like a 25 per cent improvement.

Examination by the Master.

In the pool itself there has been a substantial increase in the amount, both of solids and volatile matter in Brandon Road Pool as a result of this experiment. The total of 84,000 tons of total suspended solids which went into the pool all stayed in there except for the 21,000 tons approximate that went out, so there is a net
3879 amount of 63 or 64,000 tons stayed in of which a considerable quantity was organic. The inorganic material would not be the source of much nuisance, but the other material would.

My viewpoint on any improvement in the pool if you have increased the total amount of deposits in the pool, not merely of the inorganic matter but also

of the organic matter is: First, these solids can only exert an oxygen demand once, and they exert that irrespective of their location. If these solids were in the upper part of the canal above Lockport under the conditions prevailing before the test, they exerted there just as much leaching effect on the oxygen as they now do in Brandon Road Pool, and the 21,000 tons that have gone out of the system entirely, so far as this reach of the river is concerned, will not exert any leaching effect any place so far as the area above Brandon Road is concerned.

3880 The oxygen that has to meet the demand of the considerably larger quantity of organic matter at Brandon Road Pool has to come from the canal above in the form of dissolved oxygen in lake water, in the form of oxygen in the plant effluents, in the form of re-aeration of the surface, and these solids have only so much oxygen demand. They have been moved from the initial point where they could absorb or exert their oxygen demand to a point downstream where they are more concentrated. It is true that in a limited area there is now a very much greater demand for oxygen than formerly existed there, but considered in terms of total oxygen demand of the entire mass of sludge, about 25 per cent of the sludge is no more a part of this problem, and something like 47 per cent of the B.O.D. went out with it, and something like 28 per cent of the putrescible or the volatile matter, so that it seems to me that there has been a net improvement in the Waterway, or I should say in that part of the oxygen demand resulting from putrefying solids in the ratio of not less than 25 per cent as

measured by solids themselves and not more than 47 per cent as measured by the B.O.D.

3881 The nuisance will not come, if it does, as I view it, from the sludge itself. It results from the sludge leaching the oxygen out of the water that flows over. Now, I think it is immaterial where in the process of this water from the West Side to Brandon Road Lock that
3882 leaching occurs. I think it is important as to how much overall leaching does occur and what condition that supernating water is in to absorb the load when it is put on. Before this test it was comparatively uniform leaching, and by the time it got to Lockport the water was already bad. Now, to the extent that three-quarters of that sludge is out of that reach, the water will be correspondingly improved and will be able to absorb a more rapid leaching in the Brandon Road Pool itself, and the total cumulative effect is still some 25 per cent, as a minimum, less than it originally was. I believe that this experiment will prove to be beneficial even as to the area immediately adjoining Brandon Road Pool.

There are some things in which the experiment differed with what I thought it would and some things in which it agreed. Of course, this sludge that we referred to as light flocculent sludge on top of the heavier sludge, I think, must have been somewhat heavier than at least I visualized. I had in mind that there was a layer of sludge in there that was 2 to 3
3883 per cent solids, 97 to 98 per cent moisture. If that was the case, it has now apparently been replaced by a sludge which runs about 88 per cent moisture. I noticed by Mr. Mohlman's report that the sludge sam-

ples taken out of the superimposed layer in Brandon Road seem to average about 88 per cent moisture, or 12 per cent solids. Now, that is a sludge 4 or 5 times as dense as what I would term a light flocculent sludge. Accordingly, the scouring, has been less extensive than I anticipated. Either that or the light stuff was there and carried out and was later replaced by the denser stuff that came down from above.

Then too, the first time I thought of this flushing, I thought of it as a sort of fill-and-draw procedure in Brandon Road Pool itself; that is, empty Brandon Road Pool, or substantially so, close the Brandon Road gates and fill it up again, pull it down again, and that kind of thing. Later in the discussions that all of us had, it got to this question of increased flow, and a week or 10 days' flushing. I think all the engineers realized
3884 that when we got velocities of 3, 4 feet a second in the drainage canal we could pick up fairly coarse solids, and that when those solids hit Brandon Road Pool with its larger section, the coarser solids would tend to settle out, and that led to the discussion of dropping Brandon Road Pool's level some 5 feet, more or less. The data, I think, indicates that could that have been done there would have been substantially improved conditions. We have really only one day on which to base that, but that one day on which the water level was lowered the percentage of B.O.D. removed was a hundred per cent above the average for the other nine days. I have made some charts which, while they aren't in good shape, are illustrative of that.

(Howson Exhibit 2, entitled "Diagram Illustrating Effect of Lowered Pool Level, Carriage of

B.O.D. and Volatile Solids through Brandon Pool" offered and received in evidence)

3886 It must be recognized that when we have only a one-day period, figures are illustrative and indicative, rather than absolute, but this diagram, Howson Exhibit 2, is drawn from the data in Mohlman Exhibit 17. At the left of the diagram the ordnance shows the per cent of B.O.D. passing Cass Street which also passes Brandon Road. The average of the nine days in which there was no lowering of the Brandon Road Pool other than the six inches necessary to give it flow, 43 per cent of the B.O.D. which passed Cass Street went also past Brandon Road. That figure is
3887 taken from Mohlman Tables V and VI. I made a new table which was a consolidation of Tables V and VI. That table showed the date with respect to the tons of B.O.D.—the figures for each date appearing on Mohlman Exhibit 17, Table V. For illustration, on December 2d and 3d, 1724 tons of B.O.D. were shown as passing Cass Street and, referring to Table VI following, on that same day 406 tons passed Brandon Road. On that particular day 23.6 per cent of that which passed Cass Street also passed Brandon. I followed that same procedure through for the ten days. The ten days averaged, as Mohlman showed, 47.2 per cent. That is stated in the text of Mohlman Exhibit 17, page 2.

The 7th and 8th of December, the date on which the flushing occurred with the one foot further lowering of water surface, showed 86.5 per cent of the B.O.D. that passed Cass also passed Brandon. Deduct-

ing that figure from the total of the 10 days, 47.2, resulted in the average for the 9 days when there was no lowering of 43 per cent, which is the first diagram at the lefthand side of Howson Exhibit 2.

3888 The next or middle block on that diagram shows 86.5 per cent which was the percentage of B.O.D. that passed Cass Street which also passed Brandon on that one day when the water level was dropped one foot. Now, similarly, at the righthand side of Howson Exhibit 2 I showed graphically the figures with respect to the tons of volatile solids and the per cent which passed Cass Street which also passed Brandon Road, on the 9 days when there was no lowering, which was 24.4 per cent, and on the one day, December 7th and 8th when the water level dropped one foot, 50 per cent, and on the average of all ten days, 27.8 per cent, which is the same figure reported by Mohlman, in his Exhibit 17, at page 18.

I then prepared another diagram based on absolute tonnage carried through:

3889 (Howson Exhibit 3, entitled "Tons of B.O.D. and Volatile Solids Carried Through Pool" offered and received in evidence)

3891 Howson Exhibit 3 is illustrative of the effect of lowering Brandon Pool one foot on the tons of B.O.D. and volatile solids carried through the pool, and the same comments relative to the meagerness of the data—that is, only a 10-day period total and one-day with a lowering, applies to this exhibit as applied to Howson Exhibit 2.

Referring to the lefthand part of Howson Exhibit 3, it shows the facts relative to tons of B.O.D.—the first two lines to the left referring to what passed Cass Street, the middle two blocks showing what passed Brandon Road, and the righthand two blocks of the lefthand half of the diagram showing what was dropped in the pool.

During the 10-day average at Cass Street, 914 tons of B.O.D. per day passed Cass Street. On December 7th and 8th, 683 tons passed. At Brandon Road, of the 914 which passed Cass Street, 431 passed on the average of the 9 days, but on December 7th and 8th, 589 of the 683 passed, and that part of the B.O.D. which dropped out in the pool on the 10-day average was 483 tons per day, whereas on the one day, December 7th and 8th, when the pool was lowered, only 94 tons was dropped.

At the right hand side of this diagram in comparable blocks is shown the data relative to tons of vola-
3892 tile solids. In general, this shows again that while the tons of volatile solids entering at Cass Street was somewhat less on the day in which the water level was lowered a foot than for the average of the 10 days, the amount removed permanently through passage out of Brandon Pool was somewhat higher than that, and the amount of volatile solids dropped in the pool on December 7th and 8th was 971 as compared to 1956 tons, or about half the average, indicative, to my mind that at least the lowering was beneficial even though the figures are not intended to be absolute. Whether the condition on long test would be precisely that or something else I wouldn't want to say. I am not sure

that if dropping the level one foot was beneficial to the extent indicated, that dropping of the level 4 or 5 feet would be on a straight line of 4 or 5 times as beneficial—I doubt whether it would be a straight line. I think it would be materially more beneficial
3893 and I have drawn the next diagram simply to illustrate what happened in the first foot.

(Howson Exhibit 4, entitled "Effect of Lowering Brandon Pool on B.O.D. and Volatile Solids Leaving Pool" was offered and received in evidence)

3895 At the lower part of this diagram are laid off feet bearing from 1 to 5 for the amount Brandon Road Pool is lowered, and at the left ordnance is tons, and the diagonal lines are volatile solids and B.O.D. The data for the points platted are taken from Mohlman Exhibit 17, Tables V and VI. At the left hand border are platted the tons of volatile solids and the tons of B.O.D. per day leaving the pool during the 9 days on which there was no lowering of water. The two points vertically above the one foot mark are platted to represent the data taken from Mohlman's Exhibit 17, Tables V and VI, of the solids, volatile solids and the B.O.D. in tons leaving the pool on December 7th and 8th, the period in which it was lowered one foot. During that day there was a discharge of volatile solids at Brandon Road of 34.5 per cent in excess of the average of the other 9 days, and the B.O.D. discharge, 42 per cent increase over the average of the 9 days. The data, I believe, warrants the conclusion that there would be a material increase in matters carried out

of Brandon Road Pool by lowering and there would
3896 have been a still further answer had it been practicable or possible to have lowered the water level in Brandon Pool still further. I am a hydraulic Engineer as well as a sanitary engineer. In converting B.O.D.'s into tons—B.O.D.'s are expressed in parts per million, and one part per million is, for instance, as measured in water, a million gallons of water. A gallon of water weighs 8-1/3 pounds so that one part per million of B.O.D. is 8-1/3 pounds of B.O.D. per million gallons of water or sewage, and if that liquid had 200 parts per million B.O.D., it would be 200 times 8-1/3, or 1667 pounds of B.O.D. per each million gallons that flowed by or that was under consideration. In Dr. Mohlman's exhibit, Tables V and VI the discharge in
3897 second feet is shown averaging approximately 10,000 cubic feet per second during the test. Now, cubic feet per second is approximately two-thirds of a million gallons per day. You got the B.O.D. from the sample and multiplied that by the total volume of water passing through there. They took B.O.D. samples, I recall from Dr. Mohlman's report, each four hours, so there would be six samples a day taken and averaged, and the B.O.D. determined and applied to the amount of water flowing. You are correct in understanding from Mohlman's Exhibit 17, pages 2 and 3, that the B.O.D. figures showed that there was a substantial increase in B.O.D. in Brandon Road Pool, but it was something less than you might have expected from the percentage of organic matter that might be in and out of the pool, and the net increase in organic matter might have led you to expect a greater increase in B.O.D. than the

B.O.D. figures themselves indicate. In other words, there was some 73 per cent of the volatile solids left in the pool, but only 53 per cent, as I recall it, of the B.O.D.

The B.O.D. and the other figures are confirmed by the observation on page 2 that there was higher oxygen than prior thereto. That fits in with the figure of
3898 the actual increase of B.O.D. in the pool. The table following page 13 of Mohlman Exhibit 17 shows that the D.O. at Lockport on December 27, 1940 was substantially less than it was on the same day in 1939, although the permitted flow would have been the same in both years. (Mr. Pearse directed the Master's attention to the fact that the actual flow on December 27, 1940 was only 2,397 feet as compared with the flow on that day in 1939 of 3,8[illegible]et) That might account, at least to some extent, for the difference in dissolved oxygen on the same day in 1940 as compared with 1939, because if you take from each of those flow figures the water supply at some figure, say, 1600 second feet, it would mean that the dilution water flowing in 1940 was about 800 as compared to 2300, approximately, in 1939. I mean after deducting domestic pump-
3899 age which is estimated to be about 1700 feet in winter per day. I just took 1600. If it was 1700 the abstraction of water then would be about 700 in 1940 and about 2200 in 1939; in other words, a little more than 3 to 1, which would be certainly a contributing factor to the difference in the dissolved oxygen. There may have been other things, such as water temperature and storm conditions, but certainly that was one—an important
3901 one. May I add too that the effluents from the plants,

even though they carry some dissolved oxygen, also have a residual oxygen demand which, in general, about balances out, so that there isn't much net oxygen, if any, put in by the plants, whereas the lake water comes in as net oxygen, and the general state-
3902 ment explaining the differences in the dissolved oxygen contents in 1939 and '40, as I indicated, has some variables. For instance, referring to December 18th, there is 3.9 parts per million in 1940 as compared to .9 in 1939 and yet the flow is only three-quarters as much in 1940. I think that probably results in part from the beneficial effects still residual from the flushing which stopped about a week earlier. The next day—December 19th, the comparison is much more favorable to 1940, and from then on it is more unfavorable, and I think Mr. Pearse's explanation of it being the dilution water is the primary factor.

Cross-Examination by Mr. Clausen.

3903 Table V of Mohlman's Exhibit 17 on the 11th and
3904 12th shows at Cass Street 555 tons of B.O.D. Table VI for the same date shows 412 tons passing through Brandon Bridge. That is 77 per cent. I have it on my table as 76.9. It is practically the same. The 77 per cent on December 11th and 12th compares with 86 plus per cent on December 7-8 with a lowering of one foot—a difference of 9.6 per cent according to my figures. That is for the highest of the 9 days with no lowering you got 76.9 per cent, while your lowest day without would be 23.4 per cent.

3905 I think I can explain a little bit why there should have been such a fluctuation of 23 per cent to 77 per cent. Mr. Ramey's impromptu sketch that he prepared here this morning showed a quicker pick-up at Lockport which tapered off, and a pick-up at Brandon Road that lagged several days. To illustrate that I analyzed the days by two groups of the first five days and the second five days, irrespective of any lowering. In the first five days 37.8 per cent of what passed Cass Street also passed Brandon. In the last five days 77.4 per cent. In other words, twice as much in percentage after the thing really got going. Now, that same thing follows in rough in volatile solids. The first five days average 20.1 per cent; the last five days averaged 43.0 per cent. Of course, the last five days in each case embraces the day in which it was lowered, but taking it by two groups, it shows that the effect in the last five days, whether it be volatile solids or B.O.D. was about double that of the first five. Which supports Mr. Ramey's theory that if the experiment had been continued longer, the results would have come nearer the anticipated results, even without a lowering.

By Mr. Wallenstein.

3906 On the day of lowering 50 per cent of the volatile solids that passed Cass Street passed through the Brandon Road Locks at Brandon Road. The average for the entire test was 27.8 per cent, I tried to make it very plain that that was not an absolute comparison. It is indicative or illustrative.

3907 There was one day—the 10th and 11th, when the volatile solids passing through the same place got up to 56 per cent, and other days of the nine it got as low as 12-1/2. My answer to the question of how I explain the fact that on the days that it wasn't lowered the percentage was higher than on the day it was lowered, is that I have eight other days to see whether or not that one is out of line, and I think that it is out of line. I would expect, as a hydraulic engineer, that if I increase the velocity I will transport more material without dropping it than I otherwise would. I would say that on the only data we have it indicates something of that nature, but it isn't conclusive.

3908 I wouldn't say that the lowering of the pool on the 7th and 8th would necessarily account for the difference between 50 and 27.8 per cent, which is pretty nearly a hundred per cent, but because it is in line with sound hydraulics, I believe it is properly indicative of what would happen, not taking it as an absolute figure.

The Master.

There is a good deal of uncertainty here because of uncertainty about the density of this material and the extent to which it will sink and the extent to which it will go out and those are things you can't test precisely by any established rule of hydraulics. If we were dealing with pure water it would be easier for three competent hydraulic engineers to agree on what would happen in the lowering of the pool. It is a fair statement that here we have a complicating factor through

this foreign material so that we cannot prognosticate with certainty.

Mr. Clausen.

3910 Referring to Howson Exhibit 4, I understand from Mr. Ramey's testimony today the pool was lowered one foot for a period of about 36 hours. I had assumed it was 24 hours, so the lowering effect would also be exerted on one-half day of the 8th and 9th. The reason the amount of B.O.D. and volatile solids is so much larger on the 8th and 9th than for the 7th and 8th is that there was less coming in and less going out. The per-
3911 centage of both B.O.D. and volatile solids was lower on the 8th and 9th where there was only a half day of lowering than it was on the 7th and 8th when there was a full 24 hours, which substantiates rather than otherwise the figures relative to the 7th and 8th.

(Howson Exhibit 5, entitled "Analysis of Mohlman's Exhibit 17 to Determine Effect of Lowering Brandon Pool Level on B.O.D. and Volatile Solids Carried Out" offered and received in evidence)

Recross-Examination by Mr. Clausen.

3913 Comparing the 7th and 8th, and the 8th and 9th, the discharge of volatile solids on the 8th and 9th is less in tons with a greater discharge of flow, which indicates a lower efficiency. There was dropped out in the pool, which is really the measure I think, on the 7th and 8th, 971 tons of volatile solids. On the next day on which there was a flushing only a half day, there

was 1172; in other words, 201 tons more and the efficiency of carriage—that is, what went by Brandon that had previously passed Cass—dropped from 50 per cent
3914 to 39.5 on the next day. Table V shows 1945, for the 7th and 8th and Table VI for the 7th and 8th, 974. That is 50 per cent, almost exactly. Then when you take the 8th and 9th it shows 1920 at Cass Street and it shows 758 on Table VI at Brandon Road. The reason for the higher discharge on the 8th and 9th, I think, it shows that the efficiency of carriage from Cass to Brandon on the second date was only 39.5 per cent. The fact that there is less passed Brandon means that more settled out in the pool. The difference between those two flows is a little less than 300 cubic feet per second, which is 3 per cent. Now lowering the pool speeds up the velocity more than 3 per cent, so that the actual velocity on the 7th and 8th was higher than on the 8th
3915 and 9th. Howson Exhibit 5 will show that on the 7th and 8th the amount passing Cass was 1945—the amount passing Brandon 974—and the amount falling out in the pool 961. On the next day it will show that there was 1920 passing Cass, of which only 758 passed Brandon, leaving 1172 to drop out in the pool. In other words, 201 more tons dropped out in the pool the day the water level was restored half a day than on the day previously, dropping the efficiency of carry-through from 50 per cent to 39.5 per cent.

3916 The flow on the 7th and 8th was 9754 feet as shown on Mohlman Exhibit 17, Table VI. On the day following it averaged 10,047; about 3 per cent increase. Now I haven't figured just how much one foot lowering changed the velocity, but it is my understanding that

Mr. Andrew testified that lowering five feet would change the velocity something between 30 and 35 per cent, which would be equivalent to 5 or 6 per cent per foot of lowering. If that is true, the velocity on the 7th and 8th, due to the lowering would be about 6 per cent higher, and on the 8th and 9th 3 per cent of that 6 per cent would be counteracted by the increased flow, but the velocity on the 7th and 8th, the day it was lowered, would still be about 3 per cent greater than on the 8th and 9th.

The Master.

It is substantially accurate to say that if the velocity is increased by X, by reducing the level one foot, then it would be increased 5X by reducing the depth 5 feet in a pool such as this with vertical sidewalls or substantially that, until you get to where the bottom begins to cut in. This pool has concrete sidewalls on
3917 both sides, so that that is substantially correct, except for such variations as you might have with the irregularity of the deposits, but when you lower it, you take it off the top and the bottom stays the same.
3930 I believe, with the flows now available under the Supreme Court order, and dropping the pool level five feet at this season there would be no appreciable benefit of any kind in ameliorating the conditions to be anticipated at Joliet in the summer of 1941. I believe that would even be true with a substantial increase in the present flow because that material is now a deposit, and we know hydraulically that it takes more to scour than it does to transport. The velocity would be in-

creased about a third if we pulled it down five feet. I don't believe that changing the velocity one-third would pick up anything that was deposited under a velocity that was somewhere around three times as high. I don't believe there would be any noticeable result at all.

3931 I don't think even with scarifying or stirring up the pool by weights or any other method, with a lowering of five feet, and with an average diversion of 3150 during winter conditions there would be any worthwhile results. The scarifying, in effect, takes care of the scouring and it then becomes a transporting instead of a scouring problem, but that material was deposited there before at a flow of about 10,000 second feet and scarifying would simply restore the matter to suspension and the velocity of 3,000 second feet and the lowering of five feet in water level would still be less than the velocity at which it formerly precipitated out. Therefore, I believe there would be no appreciable result.

Sept. 12, 1940

Direct Examination.

1968 LINN H. ENSLOW, sanitary engineer and chem-
1969 ist, Editor of "Waterworks and Sewage", and
1970 consultant for the Chlorine Institute, a trade
1971 association supported by chlorine manufacturers.

Sept. 13, 1940

1980 I receive no commission on the sale of chlorine, nor is my income dependent upon the sale of chlorine. I have visited and inspected approximately 2000

1981 sewage treatment plants in the United States. The most important single thing for which I have been responsible in sewage chlorination is the control of septicity and odors and improved stream conditions below sewage outfalls in the stream.

1982 Chlorination is very much an accepted means of preventing or controlling odors and the destruction of bacteria. Chlorine is not offered as a substitute for sewage treatment works. From many pieces of evidence gathered all over the country at various plants we understand that it does reduce B.O.D. It very definitely does improve stream conditions.

1983 Chlorine I would say is used in 2000 plants or thereabouts in the United States for various purposes of odor control, destruction of bacterial, reduction of B.O.D. and attaining general stream improvement below sewage disposal plants, or for combinations of these purposes.

1985 From my opinion and general experience with sewage treatment I would say if the Chicago Sanitary District would stop putting settleable solids into the canal that would be a tremendous step in the direction of remedying or ameliorating the conditions complained of, without the diversion of additional water through the drainage canal from Lake Michigan.

1987 As another remedial or ameliorating measure available to the State of Illinois without additional diversion of water from Lake Michigan I think chlorine properly applied would go a good ways toward improving conditions. I would say, to ameliorate or remedy conditions complained of at Lockport and Joliet,

1988 an application of chlorine at the Southwest Plant of

not over three parts per million, which is 25 pounds per million gallons, with or without lime added in order to produce chloramines in the sewage proper, will carry through to Lockport in its effectiveness. Chloramines are not rapidly taken up by solids, whereas chlorine, as such, is a very rapid oxidizing material and is dissipated much more rapidly than chloramine. In water supply treatment they use Chloramine to maintain residual chlorine—excess free chlorine as it is called by some—out through distribution systems for
1989 many miles, whereas chlorine alone will not accomplish that end. In sewage treatment it seems folly to go to the expense of buying amonia to form chloramines when the effluent of sewage treatment works abounds in this amonia, as does the drainage canal waters. In order to make available this amonia naturally present we find that by the addition of a little lime the amonia becomes available just as if you were putting lime on land where you had manure—it liberates amonia. At that time if chlorine is added you get chloramines produced.

1990 When it comes to what to do at Lockport there are two alternatives. One would be to attempt to do the whole job with chloramine treatment at that point. The second result would be a combination of an aeration step at Lockport with chlorine. If we introduce along with aeration, chlorination in one form or another we get a pasteurization effect which slows up the multiplication and reduces the density of population
1991 of the organisms, and thereafter has a very marked effect on reproduction, and the longer the contact period without outside influences entering, the greater

this effect. The only thing that could disturb it, in my opinion, would be the sludge conditions in Brandon Pool. This is a bad situation and might require three or four times as much chlorine to do the same work as if that sludge were not there.

1992 The situation in the Brandon Pool looks pretty bad in every respect, but it is a bad situation when you consider whether you can control odors economically; that is, the amount of chlorine required with the Pool in the condition as I see it now will be several times more than it would be if the solids were not in an active state of decomposition.

To answer intelligently the question how many days during the year it would be necessary to chlorinate to prevent odors, I would have to see a temperature chart

1993 of the waters of the canal and pool. From my experience when the temperature drops below 62 degrees Fahrenheit, which is in the neighborhood of 17 degrees Centigrade, you do not have active sludge decomposition. Those particular organisms seem to cease operations at below 62. Without more accurate knowledge of temperatures my best opinion would be that they probably will have to start this arrangement in May, if not the latter part of April, and it probably would have to run through the month of September; that is, May, June, July, August, September. It probably would run for five months.

1994 I don't think those temperatures will go up in this latitude much before May first. You probably get active decomposition of sludge earlier, that is, an evolution of sludge coming to the surface, but as far as hydrogen sulphide production is concerned I don't

think so. That is to say, the organisms of general fermentation work at very much lower temperatures than hydrogen sulphide producers. I am referring to canal water temperatures. I have no exact parallel to Brandon Road Pool where in my experience chlorine was used for odor control. I have one case which was worse considerably; another case which is somewhat better, simpler. I will first refer to a case in this chapter on sewage chlorination, of which I have no first-hand knowledge, and I am merely now referring to literature published:

1995 (Reading from pages 106 and 107 of "Modern Sewage Disposal")

> "Chlorine may also be applied to increase the efficiency of overloaded or a partial treatment plant. With only a partial satisfaction of the chlorine demand, substantial reduction in the oxygen demand may be expected. At Bristol, England a serious odor condition was produced in 1935 by sludge deposits in the tide-locked river of Avon. Chlorination on the basis of 25 per cent of the aggregate chlorine demand at the outfall effectually checked septicity, three-day incubation period showing rather more favorable septicity figures than seven-day tests. This partial chlorination had a definite but incomplete effect on odor nuisance. Chlorination of 50 cent of the aggregate demand brought about a greater reduction of septicity. The capacity of the chlorinating equipment was insufficient to insure complete control of odor nuisance, but the mud flats of the river, which generally caused much nuisance in hot weather, became non-septic and remained so during hot August weather."

1996 The other case of which I have a little better knowledge is that right here at Downers Grove (Illinois). There they have bad odor nuisance during these months that I have mentioned of May to September, below the treatment plant which is not complete treatment. Half the plant gives complete treatment and the other portion gives only primary treatment. Unless they chlorinate they have odor nuisance downstream, and that method has been effectually used for eight summers. It is discontinued in the fall.

The most severe condition of this nature that I have seen helped by chlorine is that of the Coney Island Creek at New York City. This work was done some years ago to ameliorate a condition of hydrogen sulphide evolution from this meandering creek, and a terrible nuisance and also damage to property. The work was done on a gamble. Nobody knew what to expect. There a bleaching powder, which is hydrochloride of lime, and incidentally the same as would be produced if
1997 you ran chlorine and lime water together into a sewage, was applied to this creek by the New York City chemist, named William T. Carpenter. This article is titled "Sodium Nitrate Used to Control Nuisance". It appeared in "Waterworks and Sewage" for May 1932, pages 175 and 176. The bleaching powder was applied, first to the entire water body—the best part of it—and later applied to the effluent going in from the sewage works, but the results surpassed expectations and Mr. Carpenter, the author, writes: (Reading from above mentioned publication)

"As soon as chlorination was completed the more optimistic of the observers claimed to be able to

note an improvement in the odor and appearance of the water, but by the next morning one who had seen the conditions previously could not fail to see the change for the better. The inky blackness of the day before had given way to a brownish
1998 color and effervescence had notably vanished. The odor had not entirely cleared up but certainly was less than on the day previous."

The author goes on further to state:

"On July the 14th and 15th the average values for dissolved hydrogen sulphide in the lower stretch of the creek had been 84 and 95 parts per million, respectively. By August the 6th the amount had risen to 16½ parts. The chlorine treatment reduced this to 12.7 within an hour, and on the morning of the 7th the average value had fallen to 10.8, and it continued to fall regularly until the 14th when it was but 6.5. When the treatment was finally stopped completely, the dissolved hydrogen sulphide rose to 9.3 on August 18th. Even the mud banks exposed at low tide seemed to be deodorized. The dissolved hydrogen sulphide at the points most remote from the point of application of chemicals rose from 7.3 per million on August 18 to 8.3 on August 20, then fell steadily to a minimum of 3.2 on August 27. The two other settling points in the area gave results which showed a general decrease to the 25 when they showed total elimination of the sulphide."

Now, I want to point out that this first year of treatment in 1931 was a combination of nitrate and bleach-
1999 ing powder, the nitrate being there for the purposes of preventing septicity—a hydrogen sulphide production, and the hyperchloride being used to modify

the bacterial activity so that they would not utilize as much nitrate as otherwise. Report made by the same author to his superior, dated October 16, 1933, at the close of the second season of this application
2000 has never been published, but from my knowledge, here is what happened. The nitrate treatment was rather expensive and Mr. Carpenter did not consider it justified to continue the nitrate the second year. So they used bleaching powder alone and obtained results which were really as beneficial, if not more so, than the previous year because they continued to use bleaching powder rather than a temporary application. Then the following year they had completed the intercepting sewer and the treatment works and there was no further need of the treatment of Coney Island Creek. So, you see, this matter of chlorination is so frequently, you might say, a palliate until the permanent improve-
2001 ment can be attained. This is an example of a very severe condition and about the worst that I have ever known to show that it is possible to get improvement, if not 100 per cent remedy. The Coney Island Creek of course is salt water—a tidal estuary, and backs and fills with water, but worse than that the gas works' wastes went in and that is loaded with sulphates and really they created about as much trouble as the sea water or the sewage.

Another milder case was Houston, Texas—a bayou which is a sluggish body of water flowing down to the Gulf. This bayou receives the sewage effluent from the plant. Now this Houston plant has been for many years overloaded. They lagoon the sludge for diges-
2002 tion purposes but the effluent does carry solids over

with it because they do not have enough plant capacity to give as high a grade treatment as they do here in Chicago and other places and the chlorination at Houston has improved the condition of the bayou materially below the plant and there has been quite a lot of argument as to how chlorine does act. Some say they think it vitiates the biologic cycle and upsets it so that nobody can answer the question, but the proof of the pudding is that the condition of the stream below the plant gives evidence of effective results, regardless of theory. I would say, if I were given the task of preventing odors at Brandon Road Pool by next summer, it is my opinion I could successfully accomplish this with chlorine alone or in combination
2003 with other remedies. Yes, I agree with the conclusions expressed by Dr. Buswell and Mr. Howson as to the effectiveness of chlorine in odor control in the canal and Brandon Road Pool in comparison with the diversion of additional lake water in the amount of 3,500 cubic second feet. I can't conceive that that small amount of water would do the same thing that a sterilization effect, a pasteurization effect, such as is obtainable with chlorine or the lime-chlorine treatment, will do. As far as Brandon Pool is concerned I think if you increase the flow through the canal you would sweep more solids down into Brandon Pool that are now not in that pool, so maybe that isn't the thing to do. If the whole trouble is in the Pool down there and we want to keep the sludge out of it, then the thing to do is not to increase the velocity in the channel.
2004 I don't know how difficult it is going to be to drain Brandon Road Pool either once or successively for two

or three or more times to remove the light, active sludge which might contribute to the odors complained of and the bad appearance of the pool. If it is possible, I would do it by all means and I would do it as often as I could until the Sanitary District can finish their job of taking out all of the settleable solids. I have been around sewage plants and bad streams enough to know that there is a certain zone, layer, of what I call active sludge. Below that there is a humifying sludge that don't count and I would not go to a nickle's expense to drain it out. This active sludge is a bad actor; being down deep it settles when it is undecomposed and being deep it has this hydro pressure on it and the little bubbles of gas all through it are very small, minute, and they cannot expand and they can-
2005 not lift that sludge; but if you start to drawing down that pool—I don't know whether it will be ten feet down or two feet down—at some point there is going to be a tremendous volcanic action. The whole thing is going to turn upside down and there will be more sludge floating than there will be on the bottom. If it can be put down there out of sight somewhere and let it go, fine, that is the thing to do. Incidentally, if you do that it will be very much simpler for chlorine to
2006 have an effect on it. The sludge which might contribute to the conditions complained of in the Brandon Road Pool is a long ways down under the surface of that water and how effective the top chlorination is going to be in retarding gas evolution from that sludge I couldn't answer; but the evidence is there will be an effect which will be noticeable but how extensive I cannot answer. We now have a method of retarding

septization of activated sludge which consists merely of putting chlorine on the top water and purposely keeping it away from the sludge because we do not want to destroy a certain organism in that sludge, but they do want to destroy the general saprophytes which use up oxygen and reduce nitrates and cause trouble in sewage treatment plants. With this method we are able to take activated sludge which is a very unstable material and with that treatment we can hold that sludge three or four times longer in a settling unit so as to let the liquid squeeze out of it.

2007 I wouldn't say that nitrate oxygen would stop gas evolution from Brandon Pool or in the canal above—there would still be eructations of sludge and gas evolution—but I don't think there can be any hydrogen sulphide and, therefore, no odors resulting if there are nitrates in that water. So with chlorine or with nitrate you would be apt to have some eructation of sludge, but no odor.

2008 As to the effectiveness of introducing into the water additional oxygen through re-aeration by the construction of a properly designed cascade at or near Stony Gates, upstream about a mile from the power station at Lockport, Dr. Mohlman testified that a re-aeration of that nature would not justify the cost in comparison with the value attained on that score, that the period is short, you can only take up a definite amount of oxygen in that period, and that does not last very long afterwards in summer conditions, and he is eminently right. There have been some attempts at aerat-

2009 ing sewers in order to try to hold sewers fresh, but it has never been proven practical. If you combine aera-

tion and a method of pasteurization by any means that you like—it doesn't have to be chlorine—then your oxygen will carry through much further. Without some means of pasteurization I don't think it would be worth talking about. It would just create a local odor nuisance.

2010 I would not say that cascades apart from chlorination or some similar pasteurizing method would be positively detrimental except I would expect it to give a local nuisance—increase the local nuisance. I would say it would increase the complaints by creating a greater odor nuisance. If the figures on hydrogen sulphide is as much as two parts per million at Lockport
2011 you are going to have a nuisance if you try to aerate at that point. If there were less than that I would put in chlorine ahead of the aerating, then it would be all right. It is true, it would take a little more chlorine but the chlorination would fix the sulphide so you would not get this. As a matter of fact one of the chief uses of chlorine now is ahead of so-called sprinkling filters and that consists of a big stone bed with jets that spray the sewage over this stone and create quite an aeration by this method, liberating about every gas
2012 there is in there and in doing so taking up oxygen. If hydrogen sulphide were not present above the cascade I would say it would not be detrimental; it would have some value. I don't think it would carry very far but if the rate of bacterial activity is retarded by any means, cold weather, chlorine, or what have you, then it will have a much more beneficial effect because the oxygen will remain, it won't be sapped right up.
2013 Chlorine with cascading would be beneficial and chlor-

ine with cascading would be more beneficial than chlorine alone. There are other possible ways than by cascading of getting oxygen into the sewage or canal water. It probably could not be done as quickly nor would the construction be as economical but it certainly can be done. The method I have in mind involves a low lift pumping and a riffle type aeration, taking the water from the canal, lifting it a couple of feet or so and throwing it out over these riffles.

"Q. What would be the advantage of that over the cascade system?

2014 "A. 37 feet of head at Lockport is a pretty expensive thing to throw away, to drop water over the side of a canal, in my opinion, sir. I think you can take that power and do a lot more with it in other ways."

As to the effectiveness of chlorinating activated sludge to render it innocuous, that sewage sludge can be super-chlorinated and converted into something like paper pulp. In other words if it were essential for the Sanitary District to continue discharging activated sludge back into the canal waters, I believe a great help would result from super-chlorination of that sludge for the purpose of rendering it non-useful as bacterial food or, if useful, very slowly useful and very difficultly useful.

2015 I have seen sludges which were super-chlorinated and they just seemed to lay around without any odor and bacteria can't make use of them. How much chlorine in ratio to the million gallons of sewage is involved in that sort of treatment I am not prepared to say, but

it can be done in my opinion. Settled sewages can be dependably chlorinated to reduce the bacteria to a
2016 residual of .1 of 1 per cent, that is, 99.9 per cent of the total bacterial removed and that doesn't include the 20 degree organisms. I am speaking now of body degree organisms, and the 20 degree organisms are reduced long before the 37 degree organisms are. Partial chlorination, say 50% (and by partial chlorination I mean if the chlorine demand is 5 parts per million, partial chlorination to satisfy 50% of the demand would be 2½ parts per million) will actually reduce the pathogenic organisms by, I think it is 80 per cent. Copy of the Report of the Committee on Sewage Disposal of the Public Health Engineering Section of the American Public Health Association has already been introduced as the evidence of Dr. Mohlman in cross-examination. The committee was headed by Mr. Langdon Pearse, who is in this case, and as members, Dr. Mohlman, Dr. Buswell who testified here, Mr. Calvert, Mr. Eddy and others. There are figures presented with this report which are typical of what can be obtained with chlorination of sewage and it shows the number of
2017 minutes of contact as against the bacterial reduction or the percent of bacteria remaining, which is the same thing, and after a short contact of even five minutes the reduction is 99.9 per cent when complete chlorine demand has been satisfied; with lesser amounts, about 80 per cent. The tables referred to are on page 6 of that report. It was my conception that in order to control disinfection to the efficient degree we had to chlorinate to the full chlorine demand point, and that is to have a residual, at least a trace of residual chlorine. In

order to test out this theory, Mr. Teeterman of the New York State Department of Health and I have spent many a night and day at the Huntington, Long Island sewage plant working on that problem and this paper of Teeterman's is the outcome of that work. Here is what he says:

2018 "In solids separated from those samples containing no residual, the corresponding removals are from 96.75 to 98.5 within 15 minutes."

2019 I do not know how fast the District can operate, but I would say it would require four months, maybe five months, to get bids, secure and install everything needed for proper chlorination of the sewage and/or canal waters. If bids could be advertised promptly and work proceed it is conceivable it might run six months before they are ready to turn on the valves. That is for equipment to apply chlorine at, say, two points in the canal. The first I would recommend would be at the Southwest plant and then again down at Lockport. I am sure there would have to be some put in down there as long as this sludge condition exists.

2020 The second application would be at Lockport Power House to take care of the Brandon Road Pool.

2023 I had in mind chlorinating the canal waters—the waterway itself—at the Southwest Plant. After hearing the testimony yesterday about treatment of the West Side sewage at the point of effluent with chemicals and after hearing these reductions of 57 down to 36 by chemical treatment and thinking of the great mass of sludge involved and equipment required to install such a treatment, I began thinking how simple

it would be to chlorinate that effluent as well and get
2024 reduction in oxygen demand and this delay in bacterial effect a good deal more economically than with chemical precipitation. It is my thought chlorination would be the simpler and quicker thing to use.

"Q. (By Mr. Clausen) I didn't quite understand the time you said it would take from the time when they decided that they would go ahead and then to draw the plans and then receive the bids; just what length of time?

"A. There are no plans involved; merely analysis. The equipment would consist of Johns-Manville transite board—make a very neat building. The fact is, New York City have several of them. There is no heating involved; no insulation. The equipment involved consists of pedestal type chlorinators set in a row, and the piping of them is the serious matter."

2025 The period of time I mentioned was six months from the advertising of bids to the date of completion. If it is a necessary thing to do it can be done very quickly. In connection with the chlorination at Lockport it is very probable that the dry-feed application could be arranged there to consist of diffusion of chlorine gas into the waters above the locks or wherever it seemed most convenient to put it in. The chlorinating equipment of such capacities as I would recommend is about the size of the plan now in use at Detroit. The
2026 probable cost would be around $85,000—would not cover buildings—would cover the equipment. You would have to have two such plants which would then cost $170,000 if you use the Detroit figures as a basis,

without anything for the buildings. The buildings would be constructed of something like this transite board I spoke of. I wouldn't know how to estimate the cost of them at this time.

2027 The Detroit plant is a 27 ton plant—27 tons a day capacity, and the plant I had in mind at the Southwest Works would be about 25 tons—practically the same. At Lockport if we really want to do a job we would have to practically almost double the size of that plant.

2028 It is possible the same size plant at the two points would be all right but I cannot guarantee Brandon Road Pool will be completely and effectively controlled with three parts per million of chlorine. I know it will be helped but I don't think it will be completely controlled. I did not contemplate over three parts per million at the Southwest plant, but at Lockport I think three will help but am doubtful of complete effectiveness. If they would have aeration down there with the three I am almost inclined to think it would be all right. Dr. Mohlman testified that on January 1941 this matter of solids going in would be very much alleviated, if not completely corrected, and this will be a tremendous help.

Sept. 13, 1940

LINN H. ENSLOW—Direct Examination Continued

2070 If that active sludge were not present in Brandon Pool it is my opinion it would take just about half my chlorine estimate to do the job of clearing up those odors. Rather than, say, 6 parts per million I would say 3, and I would even say I doubt it would take any

2071 at that point if it was properly done up the canal, par-

ticularly if the canal would be, in part, flushed, that is, the active sludge flushed out when they lowered that pool.

2072 In estimating the cost of the chlorine required to ameliorate the odor conditions in the canal at Brandon Road Pool I have used the figure of 3000 second feet at the point of chlorination, and that would be at the Southwest Plant. One second foot of flow is .6463 million gallons daily; therefore the 3000 second feet is 1954 million gallons of water. One part of chlorine applied is 8.33 pounds to the million and multiplying that by 1954 gives 8.1 tons a day of chorline, so if we put in as much as 3 parts per million, and I am assuming that is the top, and chlorine at the market price delivered in Chicago is $2.16 per hundredweight, $43.20 a ton; therefore 3 parts per million the actual cost for chlorine is $1050 per day. If after this sludge removal in Brandon Pool chlorine is necessary at that point there will be an additional equal figure of $1050 a day.

2073 If no sludge is removed and an attempt is made to do it with chlorine, of course there will be an additional $1050 a day so the cost then in my estimate would be anywhere between $700 a day minimum—that is 2 parts per million—and, say, roughly $3000 for the chlorine alone.

The lagooning of sludge is essentially the making of

2074 a cesspool for depositing the noxious sludge and therein it renders anaerobic decomposition and, eventually it has to be dug out or removed by some other method to an ultimate disposal point. At Houston these lagoons are dug out of the earth and open at the top. They lagoon activated sludge entirely at Houston. It is far

from being a new procedure and it is used at many points. The outstanding example of lagooning in this country is at Indianapolis, Indiana. To my knowledge they have successfully lagooned sludge there as much as ten or twelve years. If these lagoons are properly operated there does not seems to be any odor nuisance. If they are improperly operated they are terrible.

2075 It is a difficult question to answer as to the practicability of lagooning activated sludge of the Southwest Plant as an emergency measure. If the land is available I see nothing impractical about attempting the lagooning of sludge temporarily at Stickney. I believe that it could be done with a minimum of odors, particularly if a temporary pipe line were laid to those lagoons and a considerable amount of that Imhoff tank sludge from the West Side put in those lagoons before beginning the discharge of the activated sludge. If anybody went to the brink and stuck their head over they could smell something, but so far as a general area of complaint is concerned I do not think there should be. I have seen lagoons in Toronto operated very close to habitation and all they did was to cover the surface of this sludge with a marsh grass. It kept the direct

2076 sun away and it seemed to hold the odors. They used chlorine at Toronto only in some small plants. They did not at this main plant that I am speaking of now. In speaking of the lagooning of the effluent from the West Side Plant and the excess sludge of the Southwest Plant I did not have in mind the use of chlorine at this lagoon. I see no use for chlorine in connection with it. I am recommending this as a makeshift until they can actually handle it as planned. I think for two or

three years that would be an acceptable expedient.

2077 There would be a certain amount of operating cost involved, but not much, in addition to the cost of the lagoon.

2078 I did say above West Side sludge and I meant Southwest sludge, the two being so close together I confused them in my statement. The sludge to be disposed of is the Southwest sludge; that is the one that is giving us the trouble, and when I mentioned the addition of sludge from the Imhoff tanks on the West Side that is only what we consider to be seeding material and buffer material. It is very valuable for the purpose of avoiding acid digestion and odors, so we should start off with something besides dirt in the hole and that would be sludge from the West Side plant.

2079 This last suggestion of mine did not take into account the West Side effluent at all, which is 50 per cent treated, and that would have to be cared for in some way to remove complaint about it. The suggestion I was making was merely my idea of one method of keeping these putrescible solids out of that canal

2080 and I still think that 80 per cent at least, if not more, of the difficulty we are now discussing is these solids and not the liquid. I wouldn't be able to say without knowing a lot more about it, if my suggestion were adopted, whether it would be necessary to use chlorine to take care of the West Side effluent. If chlorine were used for the West Side effluent the top would be 16 tons a day. I don't know whether you would want to use quite that much, but that would be the top. $691 a day, I believe I mentioned that before.

2081 I would say, No the chlorinator installations for chlorinating the canal would not have to be written off at the end of the emergency period, that is, the seasons of 1941 and 1942, because from my experience and the experience of many others, chlorination is a very valuable tool in an emergency. Those same chlorinators will probably serve on other days in other years if I
2085 know sewage treatment. If the problem was to correct this nuisance through to the spillway of Brandon Pool I would say that it couldn't be done for less than $3,000 a day for chlorine. That would be almost 75 tons of chlorine a day.

September 13, 1940

LINN H. ENSLOW (Recalled by The Master)

2098 Q. (By The Master) I had a note to ask you about reference to the Brandon Road Pool at the time you visited it there. I think in one part you said conditions were bad and another part that the conditions were not bad. I am not sure that I got you straight and I am not sure what you were referring to when you spoke of conditions. Were you speaking of odor or the sludge that you saw? How much inspection did you make and when were you there?

A. I probably referred to the fact that I could see from my visit yesterday, day before, that conditions there must be pretty bad in summer and, of course, the testimony shows that it is pretty bad, but that when I was there, this particular day, they were not bad. There was just a slight amount of sludge floating in that spillwater and we walked right under the dam un-
2099 der the guidance of a caretaker and could smell

very distinctly if there was any odor. In other words, above the fall you got odor if you have got it anywhere. The only odor that I could complain of, and anybody else at that visit, was the odor of oil wastes. I don't know where they come from, but there is quite a lot of oil that gets down the canal and probably oil, refining sludge, that is what it smells like. Outside of that I would not say there was an odor nuisance existing at all.

I didn't get on a boat, I only walked across the locks at the lower end of the pool and across the dam, and at the upper end of the pool we went across several bridges—two I think—and that is all. I have been there before in past years but that was before the
2100 treatment plants were in operation. I was not there in 1939 and haven't been there for five years that I know of.

October 14, 1940

LINN H. ENSLOW

Cross-Examination By Mr. Clausen

2907

2911 Enslow Cross-Examination Exhibit No. 1 offered and received in evidence entitled "Chlorination in Sewage Disposal—Discussion of the Report of the A. P. H.
2917 A. Committee on Sewage Disposal." That exhibit contains a discussion by me that is not included in the green book (Mohlman Exhibit 2).

Q. (By Mr. Clausen) Now, looking on page 54
2918 which I have marked, will you read that discussion starting at "Indianapolis" there?

A. "At Indianapolis and Flint, Michigan, the effect of chlorination had not been worth while because in each case the stream was sludge-laden below the plants and one could not expect chlorination to perform the work which should have been done by sedimentation and efficient secondary treatment. In other instances where
2919 streams were to a less degree overloaded the chlorination effect had been sufficient to tip the balance from that of almost complete oxygen depletion to that of positive oxygen balance and thereby relief from seasonal uses. Chlorination had likewise been effective in clearing up unsightly biological growths in somewhat over-polluted streams at several points where sphaerotilus growth predominated; and in other instances where algae had proved a nuisance in streams receiving highly nitrated effluents."

As far as I am concerned, I will testify to that now, and so that ends the argument. I am in agreement with those words.

2920 When I presented that discussion I concluded that sludge deposits would nullify any benefits to be derived from chlorination of a river, and they will in a large measure. My conclusions coincide with the findings of the committee, as noted on page 20, item 5, Report of Committee on Sewage Disposal of the American Public Health Association, and I would like to read this into the record:

2921 "Conclusions. In the case of a stream containing extreme sludge deposits, the effect of excess chlorine carried in a sewage effluent may be negli-

gible insofar as the maintenance of aerobic conditions is concerned."

That word "aerobic" I wish to emphasize. Aerobic is defined as a condition existing where there is not putrescence and anaerobic is a condition where there is putrescence.

2922 I take it this particular conclusion, item 5, coincides with the findings of the committee. My discussion coincides with the findings of the committee. I would say that when sludge is in sufficient amount in the bottom of a stream you can actually put residual chlorine on top of it and a mile or two down you would never know it was there.

2923 The depth of the main channel in Brandon Pool is 24 feet, I believe, and Brandon Pool's depth varies somewhat, but as I understand it it is over 27 feet deep in places.

Yes, I am informed as to the respective times of flow from Damen Avenue to Summit; from Summit to Lockport and from Lockport to Brandon Dam, with a flow of 2900 cubic feet per second.

2924 From Damen Avenue to Summit it is 31 hours; Summit to Lockport 63 hours, and Lockport to Brandon Dam 19 hours. I believe I testified, as far as I know there is no place where chlorine is used to prevent septicity for such long periods of flow in a deep river underlaid with sludge. For years I have urged application of chlorine to sewage or polluted water while it is still fresh before it has had time to become septic and odorous.

2925 I think this would be the first occasion of a condition of this particular sort that I have recommended chlorination. I recommend pre-chlorination to prevent the formation of hydrogen sulphide. Once the hydrogen sulphide is produced in the water, not less than two parts of chlorine are required for each part of hydrogen sulphide.

2926 It is essentially correct that if you allowed hydrogen sulphide to form then you must waste chlorine to destroy it before the chlorine can be of any use to repress further production of hydrogen sulphide downstream. Some benefit is secured but it is certainly a waste of chlorine to wait until the sulphide is reduced, and when you can use it at a better point ahead of the production. That is why I have always advocated upsewer chlorination where possible.

2927 (An article by the witness, entitled "Chlorination in the Field of Sanitation—Advantages and Developments in Sewer Chlorination"—a reprint from the Engineering Journal, March 1929, was offered in evidence, reading:

"Even after the hydrogen sulphide is already formed, it is possible to destroy it with chlorine. Thus, H2S plus C 1/2 equals 2 hydrochloric acid plus sulphide, but this procedure is to be avoided unless it is not practical to prevent its reduction, and when one considers that one pound of hydrogen sulphide requires 2 pounds of chlorine to destroy it, then it is readily apparent that prevention by early chlorination is less costly than destruction by later chlorination."

In my testimony I said that B.O.D. removal would be incidental in the canal chlorination and, as I recall it, I rather favored it in treating Imhoff effluent until
2928 they can get activated sludge going. In my opinion, the first step would really be to chlorinate the Imhoff effluent or influent as the case proved out, in order to help alleviate oxygen demand down the canal until a permanent remedy is provided.

2929 Yes, I recommended chlorine for odor control. I have recommended chlorine for pool trickling filters. I did not recommend chlorine for sludge in this case because I never heard of that before. I don't believe that I ever recommended chlorine for sludge filtration. As far as I know, the only time that chlorine was ever
2930 used for sludge filtration was experimentally here, and also in connection with some of the work at Cleveland, but I never did have enough real information in order to recommend it. I don't believe I ever recommended chlorine for sludge pasteurization. I don't think I have ever recommended chlorination of sludge to such a degree that the product looked like paper pulp. It can be done, I understand, but I have never done it and I have never recommended it. Yes, I do recommend chlorine for treatment of the West Side Imhoff effluent. I think under the present condition of the canal I would not recommend the chlorination of all the sewage treatment plant effluents of the Sani-
2931 tary District as a health matter, but I do believe that I would recommend it as a future consideration, and I certainly recommend it as an alleviating measure when it is necessary, say, to by-pass at intervals. I don't know enough about it to say whether I would or would

not recommend treatment with air and chlorine at the Southwest Treatment Works to separate grease. Chlorine was used for odor control of vapors and gases from the sludge dryers at Milwaukee. If it has been abandoned I don't know it. I know that it has worked indifferently. It is one of those matters where if you don't chlorinate you wish you had, and if you do chlorinate you don't know whether you have helped the matter greatly or not.

2932 In your review of my recommendation for the use of chlorine in sewage treatment I can think of one thing the Sanitary District has missed. I think possibly you might have some sewage that you can keep a bit fresher in traveling to the treatment works. Outside of that I don't think of anything.

Break-point chlorination is a coined expression and copyrighted. I will describe it as super-chlorination to the point of expelling ammonia, breaking down ammonia so that you cannot find it longer in the liquid being chlorinated. That is the best definition I could give you and the shortest. Chlorination to the break-point positively requires very much more chlorine than that required merely to satisfy the 10-minute chlorine demand.

2933 In filtering sludge at the Southwest Plant, ferric chloride is used for conditioning the sludge before it is filtered. The last I heard I though the ferric chloride
2934 was under 5 per cent of the dry sludge produced. I will take Dr. Mohlman's word for it. (The Master: Dr. Mohlman has stated that 5 to 7 per cent is correct.) When the plant produces 300 dry tons of sludge per

day that will require from 15 to 20 tons per day of ferric chloride.

2935 Roughly, it looks like 13 tons of chlorine are needed to make 20 tons of ferric chloride. No, this will not be the largest amount of chlorine used by any sewage or water plant in the United States. Buffalo and Detroit both use more. New York City uses more, but it is in more than one plant. I don't know how much Detroit is using right now. They have a capacity of 27 tons.

2936 Buffalo goes up practically to the height. I don't mean that the average is 15 tons a day, or 13 tons, but at times they are up to the full capacity of 15 tons. I am sorry to admit I don't know what the average is without looking it up. It might run less than 15 tons for the average but not a great deal less.

2937 I stated at page 2028 of the record that one 27 ton chlorine plant above Brandon Pool would apply three parts per million but I felt that twice that amount might be necessary to guarantee effective control down at Lockport. I doubled it because of the fact that even with drawing down Brandon Pool it is going to be impossible to get rid of all sludge effects, and I thought

2938 that the 6 parts per million—I just wanted to be ultra-safe. It is a speculation in anybody's sense. My best judgment is even with drawing down that pool and getting rid of a lot of sludge, still it is going to be a tough proposition. If it weren't for those solids in there I would be pretty positive about that 3 parts. I haven't changed my opinion when I stated at page 1991 of the record that the sludge in Brandon Pool is a bad situation and might require 3 or 4 times as much chlorine to do the same work as if that sludge was not

2939 there. With the sludge going in at the rate that it has been during this past summer, I wouldn't know how much chlorine it might take to control the odors from Brandon Pool. If that sludge is removed by any method whatever—and I am thinking of the poorest, the quickest method, which will not be a thorough method, but it will be an alleviating method—of lowering the pool and then letting it fill back up, and lowering it again, under that circumstance I still wanted to boost my first estimate of 3 to 6, and I still stick to that; but you understand me that I do not think that it will take all of this 6, and I don't think that 3 is going to be ample in real hot weather on that pool; even though we use lime along with chlorine to get chloramines. I still want to be perfectly safe about this matter and say 3 to 6, with the sludge removed by the best way you can—by lowering and filling and filling and lowering the pool.

2940 Without the sludge removed I would say it would be anybody's guess as to the amount of chlorine required to do the same work. If we don't take the sludge out of that pool, I wouldn't know what to say about it. It would be like Coney Island Creek. You would get some alleviation, but you would still get a smell—a smell instead of a stink, we will put it that way. I wouldn't say that if you don't drain that pool, and that you don't put any new sludge in, but you leave in that pool what is there now, it would take an extraordinary amount of chlorine to give you any assurance that you

2941 would eliminate the odor at the pool. If no new sludge goes in, I wouldn't worry about sludge which was put down there last summer, next summer. I would be worrying about the sludge that is going in now from

June or May because that is accumulated and when the right temperature conditions arrive you have a conflagration of kindling that you have been packing into that pool all winter that hasn't burned. Assuming that (1) the pool is not drained, and (2) that sludge continues to go in for the next few months at the ex-
2942 tent to which it has been going in, I would say that if 12 parts per million of chlorine did it, it would be a fair job, and it might take another 3 to 6 parts. I might say that a good many sewages are chlorinated with 25 parts per million of chlorine on that account because they are septic and have a very high chlorine demand. All you would have down there would be a giant septic tank served from the City of Chicago and you would have to put in 25 or 30 parts of chlorine I wouldn't know whether it would take 15 parts or 25.

If fresh deposits of sludge were terminated so that after January 1 1941 there would be no new sludge put in, but the pool not drained, I don't think you would be very successful in the early spring when the boiling begins. You would get some odors there with a very high amount of chlorine that wouldn't sound practical at all, and as the summer wore on and the excelsior part of my kindling and fuel is passed on, you see no more coming in, then I would go back to my 6 parts.
2943 9 parts per million would be about 75 tons a day, and 12 parts would be 100. As long as that sludge is active in that pool I don't think anybody can tell you the answer because here is what happens: You will be going along with a good chlorinating effect and then all of a sudden you get this boil started and it just impregnates the whole pool, and that is going

to smell bad when it goes over the dam, and it will have hydrogen sulphide in there. Until the amount of sludge that has been going in during the last several months is stopped, a confident opinion about the amount of chlorine that would eliminate odors could hardly be expressed.

2944 The cost of $85,000 for a 27 ton plant at Detroit as stated by me at page 2025 of the record, included supervision of installation and drawings but it did not include miscellaneous accessories or hard rubber piping, which will add, apparently, about another $25,000 to that figure. I would say it is a fair statement that the auxiliaries and pipes would make the cost about $115,000.

2945 That wouldn't include a building. For this summer situation, I hadn't anticipated any heating. There would be involved a railroad spur on which you would have a tank car of liquid chlorine, just as they do at paper mills, and pipe it any distance you might wish into ordinary heavy-weight iron pipe to the so-called evaporators, and there the liquid chlorine goes into chlorine gas, and from that point it goes through gas meters of the chlorinating machines and into the water solution; or in this case it would be canal water solution, and on into the sewers. New York City does a lot of this seasonal chlorination and they have to cool these buildings and not heat them. They cool them by opening the windows.

2946 The bid to the City of Detroit on chlorinators of 54,000 pounds capacity, that is 27 tons, was $67,000. That is the actual bid price and this did not include any of the evaporators and some of the accessory equip-

ment which is normally a part of the chlorination contract for which an allowance of $10,000 should be made. I would say that with the labor situation in Chicago that it would probably be $115,000 for the construction of that plant with auxiliaries and piping costs. To a certain extent I collaborated with Mr. Howson in the preparation of some of these exhibits that were introduced this morning. He has taken a good deal from my letters. If this item 3 in Exhibit 12—approximate cost to install for chlorination of canal waters—did in-
2947 clude the auxiliaries and piping and so forth, it included a darn sight better building than I would ever put up for it. I talked to Mr. Howson about that and asked him where he got that $360,000. If I say that it cost $120,000 to put the Detroit job in Chicago—duplicate the Detroit installation in Chicago—it wouldn't be twice that much to make it twice that large. There is one pipe line that takes all of the flow of the chlorinated water, and if you have twice the capacity it doesn't take two of those pipe lines. It merely takes an 8 inch instead of a 6 inch, or a 6 inch instead of a 4 inch pipe, so that labor, bolts, and all that are the same, no matter whether it is a 4 inch pipe or a 6. Consequently those estimates are high.

Redirect Examination By Mr. Naujoks

In indicating that I had no hope that chlorine would be effective at Indianapolis, that is a pretty bad situation. It isn't any too good yet. What they needed was
2948 a bigger treatment plant and very much so in Indian-

apolis. I don't believe Mr. Calvert ever conceived or nourished the idea he could save enlarging his treatment plant by using chlorine at Indianapolis. Mr. Calvert proceeded to invent a method of adding chlorine to sewage and after that he began to make some studies of the stream but as far as I know he didn't make any hydrogen sulphide study. The river, as far as I could picture it looked just as bad when he chlorinated as when he didn't, and it was sludge laden and no dilution water to speak of. That he did have was pretty well polluted and had about 4 parts per million of dissolved oxygen coming down to the sewage plant and the whole matter was one in which chlorine should never
2949 have been given serious consideration. In Indianapolis it was very definitely a failure. There isn't any problem down at Brandon Pool now. I was down there yesterday (October 13, 1940) and the only odor coming from the canal was just a sewage odor—smelled like urine, amin and did show that sewage wasn't overly well-treated at that time; but it wasn't any hydrogen sulphide odor and nobody could complain of it half a block away from this turbulence at the locks. As far as I could see the odor that would be complained of is oil field wastes. I didn't smell a great deal of hydrogen sulphide but I smelled something even more nauseating and that is the mercaptan, and very distinctly sulphur compounds and it might be what is causing the
2950 paint to turn black. If I understand the situation that oil waste has merely developed within the last year or two, but to my mind it is a distinct nuisance right now.

2951 I was here and there yesterday at Brandon Pool.

I was not in the City of Joliet, I was nearer Lockport. I would say there wasn't more than a trace, a good deal less than a half a part per million of that hydrogen sulphide present yesterday judging by my nose.

2952 I have got a kind of a sharp nose and I can differentiate between 1 and 2 parts per million hydrogen sulphide in the sewage that is being aerated. In other words if I could take a sample of sewage and shake the jar and smell it, I could determine it.

2954 (The Master: For the purposes of this record, we can agree that the area of the controversy (as to odors) is limited to a point bounded on the north by Lockport and bounded on the south by the lower locks at Brandon Road Pool.)

Berak point chlorination is primarily a development in water purification to overcome pollution in the source of supply. I don't believe anybody would wish to consider break-point chlorination to sewage treatment.

2955 (Discussion between counsel and Master relative
2956 to permitting witness to read from Article "The Efficiency of Chlorine in Sewage Disinfection and Affected by Certain Environmental Factors" by William Rudolfs and J. V. Ziemba of the Sewage Experimental Station of New Brunswick, N. J. Agreed that if Master wants it for his own study, it could go in without reading)

2957 Well, I was rather anxious, in having read some cross-examination testimony here, to correct an impression which the Master seems to have got, and to my mind wasn't corrected, that if you started with residual chlorine and you got downstream half a mile and it

disappeared, then you were just out on a limb, so to speak, and you had to grab another limb which was more residual to carry on further, and consequently it was chlorinating here, there and all the way down every few miles at least. I am introducing this to indicate that that doesn't have to be so, and we are actually chlorinating in sewers a good distance ahead of the treatment works and getting results; but in the instance of this canal it is a lot easier than chlorinating a concentrated sewage floating down a sewer in contact with slime and oxygen which encourages a splitting of sulphates into sulphides. The evidence I am trying to present is to this effect: If we start with a fraction of the complete satisfaction of chlorine
2958 demand and if we give a sufficient contact time, according to these investigators a 77 per cent reduction of bacteria with 20 per cent of the chlorine demand after 7 days becomes 98 per cent. It is slow and progressive, and 54 per cent becomes 92 per cent after 7 days.

This is really a laboratory study. There was no sludge present in this case. It doesn't say the size of the bottles here, but it is indicative of the fact that unless you have continual receding from such thing as sludge boils going on, or from a side influence, a polluted stream flowing in, that you can expect to get bacterial reductions which are not chopped off and then flare up, but they go along at a smoother pace than that, and here is what the authors say:

"The effective disinfection of sewage does not depend upon the persistence of primary chlorine, free
2959 chlorine hypochlotates or hypochlorous acid. Sewage disinfection is effected by the germicidal chloro-

organic products produced by virtue of reactions between chlorine and organic compounds. Bacterial reductions produced by chloro products are very small when the contact time between the chlorine and the sewage constituents is short, for the amounts of chloro products formed are comparatively small. Increasing the contact time results in the formation of more chloro products and consequently a greater bacterial reduction. In this process the early bacterial reduction is produced with primary chlorine, but with longer reaction periods the bacterial reductions are caused to a greater extent by the chloro products."

I refer to this article to correct the notion that chlorine wears off and would have to be renewed at short intervals. I cite this article to show that chlorine does not wear off so quickly but the effect of it will continue over a period of time.

2960 If you chlorinate to 50 per cent of the chlorine demand, and you have a long enough contact, you come out with better than 90 per cent and a good many times almost 99 per cent of bacterial removal; whereas if you wish to 'o that in a short period of time, say you would have a contact period of 10 minutes, you would have to go the whole road, and have residual chlorine and maintain it for a time, at least, say, 10 minutes, and then you have gotten a result which is in line with what you would wish to put on a bathing beach; whereas, in this canal condition I am not considering a sterilization in any respect, I am considering a disinfection action which is a horse of an entirely different color.

2961 With sludge present in the canal, it will be different if the sludge boils up from the bottom and is present in sufficient amount to vitiate the results. Under present condition of the canal that might happen, but I don't anticipate that that sludge is going to be in that canal too long.

If the sludge were kept out after January 1, 1941 I think I could control that through the power station. That is easy, in my opinion. The gamble is on Brandon Pool, and that is why I don't know whether it will take 3, or what it will take. Incidentally, we would not attempt to hold dissolved oxygen in that pool. It wouldn't be necessary, in my opinion, nor as far as
2962 that goes, in the canal either. Dissolved oxygen is a useful material for fish but I don't believe that the City of Chicago is going to raise fish in that canal and Brandon Pool, and if chlorine will assist in keeping down putrefaction and sulphate splitting which gives sulphides, although there is no dissolved oxygen, then that is my idea of a method of keeping down odor nuisance and not spending too much money in doing it. I think I testified that when the Sanitary District finishes its plants and no new sludge goes into this waterway, and the sludge that has been in Brandon Road Pool has been there long enough to lose its potency, I doubt whether chlorine would still be advisable, except possibly during the hottest weather. I don't think there is going to be a great nuisance down there when that situation is cleared up. If a nuisance condition became likely in the hottest weather, I believe Dr. Mohlman and the rest of the experts can do something which

will be equal to putting through more lake water, and
2963 that will be chlorination.

As long as there is sludge going into the stream or as long as there is sludge in Brandon Road Pool which hasn't lost its potency, it is speculative as to the extent of the efficacy of chlorine, whether it would be 100 per cent alleviating or 90 per cent or 70 per cent. I wouldn't want to stake my reputation on saying it would be 100 per cent. On the other hand if we complete the treatment, and the Brandon Road Pool stuff loses its potency then we wouldn't need any chlorine except in cases of by-passing, or something of that sort.
2964 It is quite a common practice to include chlorination in modern sewage treatment works, and I would venture to say that three-fourths of the sewage plants now being built almost automatically include chlorination at some point or other. In New York State it is almost required now to have chlorination in every sewage plant and I believe other states are doing similarly.

October 17, 1940.

LINN H. ENSLOW

(Redirect Examination)

3213 Yes I talked with Mr. Calvert at some time or other with reference to the experiments he conducted at Indianapolis to which he testified in this case. I cannot give the date when I was first consulted but it was immediately after a certain meeting of the Central States Sewage Works Association and I went with him to his plant and found that he had planned this chlorination for it and also to develop certain forms of chlori-

nating equipment for the purpose. I offered to arrange for Mr. Calvert to obtain the use of regular chlorinating equipment so as to facilitate the work, but he didn't
3214 wish to use it, and so proceeded to develop this feeding device and to carry on the work. The next information I had of the work was in the form of an article which was presented before the American Chemical Society. I merely want to point out that I was not familiar with the work in progress, and as a discusser of Mr. Calvert's paper I stated very frankly that I could see why the experiment had failed but my knowledge of the river conditions below Indianapolis was next to nothing. As a matter of fact, I have never seen the river at the points on which this sampling was done, and haven't seen it to this day, so I don't know the exact conditions. When I testified that the Brandon Road Pool situation and canal were not parallel with Indianapolis, I did so on the strength of the plant effluent—the mixed activated sludge effluent and the settled sewage, the number of pounds of B.O.D. compared with the number of pounds of dissolved oxygen in the diluting water, and the ponded condition below Indianapolis which, I understand, was one pool after another, and sludge eructations were rather continuous and receding of the plant effluent to the place all the way down the river. Mr. Calvert, after these experiments were
3215 over and after the results were published, thought he might try it again the next summer using the lime chlorine process rather than the straight chlorination as he had done before and I discouraged that. I never did think that chlorine at Indianapolis was right for trying to improve that stream. It was too evident that

the treatment works were inadequate. The amount of water in the stream was also inadequate and I couldn't conceive of chlorination taking the place of a higher degree of treatment at Indianapolis.

It is my opinion that the Indianapolis situation is wholly different from the situation we have here in Chicago because of the fact that Chicago is certainly going to stop putting sludge into the canal and I believe they have practically stopped already. The other thing is that the Indianapolis sewage was a good deal stronger than Chicago and still a further consideration, in my opinion, is that the Indianapolis application of chlorine was never perfect. It was deficient in its
3216 application, and by that I mean that it was not distributed in the best fashion and at times there all of the chlorine was put into a portion of the sewage flow, the activated effluent, and then the two effluents were run together. Now, that is not efficient chlorination of plant effluent. I don't say, though, that if it had been 100 per cent efficient it would have answered that problem, but when Mr. Calvert observes 10 per cent in plant practice versus 20 to 30 per cent in the laboratory tests, it is evident why that differential appears.

September 12, 1940.

Direct Examination By Mr. Naujoks

1888 ARTHUR M. BUSWELL, Chief of Illinois State Water Survey and Professor of Chemistry, University of Illinois, subpoenaed to give testimony before The Special Master.

1889 Beginning with 1908 I have been actively connected with water analysis and water treatment, both from sanitary and industrial standpoints. I was asked in 1934 by the P.W.A. Board of Review on the Sanitary District of Chicago project to give a report on certain questions which were asked in connection with the possible methods of obtaining complete treatment of the West Side sewage of the Sanitary District of Chicago. Among others was the question: "Do chemical precipitation processes of sewage treatment merit serious
1890 consideration (b) as a means of supplementing the existing Imhoff tank installation on the West Side?" To this question my answer was "Yes, with proper doseage a 75 per cent purification would be obtained." That is still my opinion. The effect of using coagulating chemicals is to increase the removal of the B.O.D. load and experiments which I have carried out at other plants and other experiments which I have observed, improvements from 60 to 75 per cent have been obtained. It was on the basis of that that I made my answer to the Board. The chemical treatment is not exactly a standardized process. There are various chemicals that may be used and the 75 per cent was based on the assumption that the optimum dose of lime and coagulant, such as alum or iron, and inert material such as clay or paper fibre, an absorbent I would say, rather than inert,—clay or fibre paper or something of that sort would be added to the inffluent.

1891 In answer to the questions submitted to me by the P.W.A. Board of Review I further stated: "The sedimentation compartments could be used substantially in their present form". That is still my opinion. I

haven't reviewed the figures, but at that time I remember checking volumes and capacities and so on and there was ample time for the coagulation to take place in the sedimentation basin. The addition of chemicals will not interfere with the digestion in the Imhoff tanks. In fact the addition of lime is frequently recommended in connection with digestion. The addition of chemicals will not interfere in any way with the drying qualities of the sludge. The chemicals tend, if anything, to improve the drying qualities of the
1892 sludge. I haven't made any recent calculations based on current markets but the chemicals required to treat the influent of the West Side sewage would probably run between $5 to $10 a million gallons and the operation and supervision cost would probably run $15 a million gallons or thereabout. Those are very approximate figures not recently checked. An increase in air in the activated sludge plants of the Sanitary District of Chicago beyond that required to merely produce bio-precipitation, results in the formation of nitrates and nitrites from the nitrogenous material in the sewage.

1893 There is no advantage in having nitrates and nitrites in the effluent of an activated sludge plant if it is discharged into a clean stream. Assuming that the effluent from the three activated sludge plants of the Sanitary District of Chicago is dumped into the drainage canal which, at the present time, carries a B.O.D. load of from 20 to 25 parts per million, then the presence of nitrates and nitrites in the effluent would be beneficial. It has been known for many years that nitrates carry oxygen available for the stabilization of the

B.O.D. load. I do not know of any streams with nitrates and nitrites present in the water where septic conditions occur. Nitrates in my experience tend to oxidize hydrogen sulphide if it is produced in some portion of the stream and also to prevent the formation
1894 of hydrogen sulphide. The bacteria in decomposing organic matter requires oxygen in order to burn the organic matter and supply energy for their growth, and they take oxygen, first from the dissolved oxygen, and then from nitrates, and then from sulphates; and the end product left when they take the oxygen away from sulphates is hydrogen sulphide. One part of nitrate nitrogen would carry 48/14 parts, or approximately 3½ parts of oxygen. Oh yes, there would be odors if there were nitrates present in Brandon Pool at the present time. If there always
1895 had been nitrates present in sufficient excess I wouldn't expect odors under those conditions. If the pool were cleared of the old sludge deposits and in the new water nitrates were maintained then there would be no odors arising from the sulphate. The source of hydrogen sulphide in very large measure is the sulphate mineral salt dissolved in the water and in the body of the sludge that is reduced to hydrogen sulphide, and then reduced organic compounds formed in the digestion react with the sulphates in the liquor above the sludge and so the hydrogen sulphide is produced from the dissolved sulphates throughout the body of liquor if zero oxygen and zero nitrate conditions exist. Hydrogen sulphide comes almost entirely from dissolved sulphates.

1896 The generating element in producing hydrogen

sulphide is organic. From analyses of gas from similar situations I would expect that the principle constituents of the gas that bubbles up through the water in Brandon Road Pool is largely methane—an odorless and colorless gas—and an appreciable amount—perhaps 20%—of carbon dioxide—ordinary carbonic acid —and probably three or four per cent of nitrogen. I would not expect to find more than 1 per cent of hydrogen sulphide, if that. It is a fact that chlorine is widely used as an agency for the sterilization of bacteria and the prevention of odors, and chlorine is effective in the reduction of B.O.D.

1897 To answer the question whether chlorination of the sanitary canal and Brandon Road Pool would not, as a temporary measure for a two year period ending in 1942, be a better solution for the prevention of odors now complained of than by the addition of 3500 cubic second feet more of lake water, I should have to make a complete oxygen balance on the organic matter in the canal as against the oxygen which would be carried by 3500 second feet of lake water and consider the possibility of that oxygen all actually being used to prevent odor. However, chlorine has been, and is, used effectively to destroy odors and is prompt and effective in its action. I would say, I would be sure that the chlorination of the canal water applied at proper place or places would relieve the odor condition. In other words I am sure that chlorination properly applied in the proper doseage and at the proper place or places in the canal would prevent the odors complained of, but I am not certain that lake water would do the job without further study.

1898 It has been mentioned that there is considerable sludge at the bottom of the canal at the present time and I don't believe that any amount of diversion could be depended on to remedy the odor within any reasonable length of time unless that sludge were removed.

Examination By The Master.

If properly applied it is my opinion that chlorination would relieve the odors, notwithstanding the deposits of sludge that exist now in the waterway and the Brandon Road Pool. Of course, if at certain times an enormous amount of bubbling occurred locally, it might not be possible to maintain enough chlorine to take care of all of that. I haven't seen the Pool; I don't know how much of that is going on. Ordinarily it is feasible to maintain enough concentration of chlorine in that liquid to take care of odorous compounds which would be given off from the sludge and in the liquid itself.

1899 Ordinarily from 5 to 10 parts per million is enough chlorine to sterilize ordinary untreated sewage. To maintain chlorination of the Brandon Road Pool and the waterway, excluding the additional sludge and untreated sewage that is going in daily, I would think that all the way from one to three parts per million of chlorine would be enough to deodorize the liquid as it flows in the canal. In order to work out the total figure I would have to determine how many million gallons there were there.

1900 Chlorination would have to be done only in the portion of the year when nuisances occur. In other portions of the year the temperature is low, putrefaction is

slow and reaeration is rapid and chlorination can then be omitted. But in times of the year when the temperature is high, putrefaction rapid and reaeration slow, the chlorine combines with odorous compounds, decomposes them and, in effect, lengthens the available time for reaeration; and in some cases of which I have read the reaeration is sufficient to prevent further development of nuisance downstream. It requires calculation to determine whether one application of chlorine would be adequate.

September 24, 1940.

A. M. BUSWELL

Direct Examination Continued by Mr. Naujoks

2214 From the flow in the canal shown in the testimony
2215 of other witnesses, it appears that one part per million treatment, figuring the chlorine at 2.14 cents per pound would cost $360 per day. In my testimony the last time I stated that in my opinion one to three parts per million would be sufficient to alleviate the nuisance and I am still of that opinion, assuming that the sludge is no longer discharged from the Southwest Plant. As to the point of application of the chlorine I would say that below the dam at Lockport would be the point for the principal chlorination and, in my opinion, an average of from two to three parts per million or from $720.00 to a little over $1,000 per day worth of chlorine would be sufficient applied at that point to remove odorous substances and probably over a period of not over 100 days.

The principal focus of odors, according to the testimony at any rate, appears to be in the turning basin

in Brandon Pool just above the locks, and it would seem entirely feasible to introduce chlorine directly at that point by means of a boat or barge. This is by no means a new practice. Swimming beaches and various places have been disinfected with what are known as chlora-boats. Such a barge to carry enough chlorine to treat as high as three parts per million,
2216 based on the volume of that more or less stagnant basin would probably not cost over $10,000. I obtained figures for the different pieces of equipment that would have to go on such a barge from the Wallace & Tiernan Company, dispensers of that type of equipment. Treatment of one part per million per day in that pool I figured at $50 worth of chlorine so that taking the whole situation in view, assuming chlorination below the locks at Lockport and a chlora-boat in the turning basin at Brandon Pool, it is still my checked opinion that an average of three parts per million per day should take care of the situation. Now the sludge from the Southwest Plant, according to records, amounts to 90 tons or 180,000 pounds per day and that by various means of estimation would amount to the equivalent of about 120 tons of B.O.D. per day, and figuring the other loads discharged into the canal the total B.O.D. load appears to be in the neighborhood of 400,000 pounds. If the sludge is removed or no longer discharged it would appear to relieve the load by about 25 per cent, so taking that into account it is my opinion that an average of 5 parts per million per day should
2216 take care of the situation with the sludge discharged into the canal, applied in those conditions and at the particular focal point of the nuisance.

September 24, 1940

ARTHUR M. BUSWELL

Cross-Examination By Mr. Clausen.

2250 I would not put in any chlorine above Lockport. I would not increase the amount of chlorine at Brandon Pool more than if I were introducing it both at the Southwest Plant and at Brandon Pool. My understanding is that the point of difficulty is Brandon Pool, Brandon Pool being defined as the entire water below Lockport to the Brandon Road dam. Three parts per million at Lockport with a flow of 3000 cubic second feet is figured at about 16,000 pounds per part per million. It would be about eight tons per part per million, or 24 tons I suppose.

2251 Q. (By Mr. Clausen) Now would this not have to be increased unless the sludge could be removed at Brandon Pool?

A. It is my opinion that the sludge in Brandon Pool has received undue emphasis from the technical standpoint of this problem. Sludge lying quiet, as it would, assuming that the flow was less than half a foot per second would undergo what is known as anaerobic decomposition, self-stabilizing, without the consumption of any oxygen. The quantitative evaluation of that would be a complicated problem, but in many cases flowing water, flowing evenly at a relatively slow rate, will show dissolved oxygen at or near the surface when sludge in the bottom will be in a decidely septic condition as shown by stirring it up.

The gas evolved from sludge in the bottom of a stream is ordinarily discharged intermittently in places,

and in other places the gas will work up continually from the bottom without causing any rising of sludge; in other conditions you might have slow evolution of the carbon dioxide and methane, both of which are odorless gases, without the lifting of sludge.

2252 In referring to Brandon Pool as a stagnant pool, the turning basin of Brandon Pool would, from my observation, have very comparatively little flow. The amount of water required for locking boats would be about all the through flow that there would be in the turning basin. That is where I want to put in chlorine. 3000 cubic second feet does not flow through the turning basin of Brandon Pool every day. The dam is over at one side and the bulk of the flow is over at the dam and the turning basin is down below in a sort of a loop, and the lock is at the lower end of that turning basin. The only flow through that would be in the lockage water. I don't know how many cubic feet per second goes through there. I would have to take the lockage and multiply it by the amount of water taken. It is relatively small in proportion to the 3000 second feet.

2253 It is my understanding that it isn't a straight pool and it receives practically no water except rain water. Some of the testimony indicates some trade wastes discharged into that pool $50 worth of chlorine in 3000 second feet would be only about a seventh of a part per million. At 2 cents per pound $50 worth would be about 2500 pounds per day. One part per million would be 16,200 pounds per day. On the basis of the total flow $50 worth is only about .15 or 1/6th of a part per million. That wasn't my original testimony. My answer to the Master was based on an estimate of

the volume of the comparatively stagnant turning basin, and is not based on any accurate survey, but
2254 it is an approximation of the volume of the turning basin.

Examination by the Master.

My testimony this morning was $1000 a day for about 100 days over all. But the questions, so far as I understand them, apply to my suggestion that chlorine be applied at a second point, namely, precisely in the turning basin where the water is comparatively stagnant and where one would expect the worst condition to exist, and it has a comparatively restricted volume of water, being much smaller than the total flow through; and there $50 per day would provide one part per million per day treatment if my estimate of the volume of that pool is anyway near correct.

2255 It is my very approximate estimate that over all one part per million per day for 100 days in this pool, and three to five parts per million at Lockport, depending on the condition above Lockport, gives an over all figure of $1,000. When I say "over all" I meant to say a summer's operation. Some days the amount of chlorine applied at Lockport might be much over three parts per million. The amount applied down in the turning basin might be much over one part per million, still over the 100 day period for any given summer it is my estimation that somewhere between $1000 and $1200 per day would be the chlorine cost.

I wouldn't want to be on record—stake my reputation—that that would be a correct statement of what

I figure would be the total chlorine cost to effectively meet the odor conditions complained of at Joliet and
2256 Lockport. I have, of course, been supboenaed in this case. I have not given a great deal of study to it, but I find that the amount of water which is requested to alleviate the conditicn would supply approximately one-third of the total B.O.D. In other words, the problem there is to alleviate the condition and it is my opinion that the introduction of chlorine in the amounts mentioned would very largely alleviate the conditions. I am basing that on testimony and extensive records where amounts comparable to that, and not very much larger, have been used in alleviating nuisances where the liquid was raw sewage with 8 to 10 times the B.O.D. of the water at Lockport. It is my opinion that this expenditure in removing the conditions complained of at Joliet and Lockport would be as effective as the oxygen from the additional diversion and I would stake my reputation on that.

Cross-Examination by Mr. Clausen.

2257 I don't know what the maximum is you would have to have. I know that some days, according to the testimony and many inspections, there has been no nuisance down there. There wasn't any Saturday morning (September 21, 1940). I took a drive down there Saturday morning. My estimate was based on equipment to got up to three parts per million per day in Brandon Pool. The average treatment I estimate not over one part per million per day down

in the turning basin, in the Brandon Road Pool proper, and three parts per million at Lockport. My estimate is based on a review of a report on chlorination which showed the amounts used in many places where chlorine is used to alleviate odor and nuisance immediately below sewage treatment plants with inadequate preliminary treatment as, for example, simply screens or sedimentation, or something of that sort. To make an accurate calculation, based on what has been done elsewhere, you would have to compare figures as to dissolved oxygen, B.O.D., velocity of stream, amount of water coming in and other elements.

2259 All of those things would have to be balanced to permit me to say that I had reached an opinion on 2260 which I could stake my reputation. It would require an experimental program. It really should be done actually under the conditions of the canal. The reactions of chlorine with waste matter do not follow simple chemical laws. It is not possible to calculate the exact amount of chlorine under any given condition the way one would calculate the amount of lime required to soften water for example. One could not sit down and take the figures supplied by the Sanitary District as to B.O.D., dissolved oxygen, temperature conditions, tons of sludge deposited in this stream, size of the stream, velocity, amount of water coming through and then comparing all of that data with data available in reports of other situations reach a definite conclusion without actual experimentation with chlorine on the spot. If the information were available on what is known as to the immediate B.O.D. demand, or 2261 the chlorine demand or the hydrogen sulphide by ac-

tual chemical determination in this stream, a more reliable figure could be obtained; but it is certain that one part per million applied to the turning basis and three parts per million applied below Lockport would in a great measure alleviate the condition, because from 5 to 10 parts per million has been found to alleviate conditions where the B.O.D. was eight times or more the B.O.D. in the discharge into Brandon Pool. The data referred to a few minutes ago is available in this report "Chlorination in Sewage Treatment" marked "Mohlman Cross Examination No. 1" which is submitted in evidence and Mr. Ellms' testimony which I read, indicate 10 parts per million—7 parts per million in pretreatment and 3 parts per million post treatment on the raw sewage. The specific data which would be helpful would be hydrogen sulphide figures on Brandon Pool and immediate B.O.D. and chlorine demand.

2262 (The Master) "Dr. Mohlman says it is not available".

I am confident without further information (a) that the quantities of chlorine to which I have referred would substantially ameliorate conditions although I could not be confident it would eliminate all odors, and (b) that I am confident the quantities of chlorine to which I have referred would give as much amelioration as 3500 additional cubic second feet from Lake Michigan.

Cross-Examination by Mr. Clausen.

2263 I am the same person whose name A. M. Buswell appears on page 46 of Mohlman's Cross-Examination Exhibit No. 1. It may be I subscribed to the statement on page 20 under Item 5:

> "In the case of a stream containing extensive sludge deposit the effect of excess chlorine carried in a sewage effluent may be negligible in so far as the maintenance of anaerobic conditions is concerned." and I subscribed to the statement on page 30—"Investigators agree that fresh domestic sewage containing some dissolved oxygen is not offensive and that odors of an offensive nature are derived generally from decomposition in the absence of dissolved oxygen. When sewage solids accumulate a sludge decomposition sets in. Sludge banks, therefore, may prove offensive even though overlaid by a liquid containing some dissolved oxygen."

2264 I haven't made any estimate of the maximum amount of parts per million that I would introduce at Lockport. I think that some days none would be required and that would be the minimum. There probably would be days that would require more than three parts per million. The sewage treated by Mr. Ellms, as I understand it, had a B.O.D. of about 100 or 150 and the B.O.D. in this liquid is stated to be 25. Mr. Ellms treats this post-treatment with three parts
2265 per million. I would have to base my amounts of chlorine on summer conditions. I have had occasion to put chlorine in sewage at Balston Spa, New York. That was in 1914, 1915, 1916, 1917 as nearly as I can

remember. I used 50 parts per million there. That was an attempt to kill anthrax. Anthrax is dangerous to men and to cattle who might drink the effluent or plant containing the anthrax.

2266 So far as I am aware that is not a part of the Chicago problem. The $1000 to $1200 per day cost represents just the cost of the chlorine and does not include the cost of installation including the equipment and the handling of the chlorine. I have not determined the cost of the chlorine plant to be installed at Lockport or estimated the cost for handling the material.

Examination by the Master.

The chlora-boat that I spoke of would be used only at the Brandon Road Pool and there would be another installation required at Lockport.

Cross-Examination by Mr. Clausen.

2267 I have not made any tests but I believe it appears in the testimony that the drainage canal is devoid of oxygen in the summer for more than twenty miles—just below the Southwest Plant to Lockport. As I remember reading Mr. Andrew's testimony he said there was hard dense sludge of 3 to 4 feet, which would presumably be a stabilized humas. That above that there was some indeterminate amount of light, thin sludge. Lake Michigan water is used for dilution of Chicago sewage and Lake Michigan water is what you would call clean water when used for dilu-

tion of sewage. I don't know what the 5-day B.O.D. of Lake Michigan water is—not very much probably.
2268 The 5-day B.O.D. of any raw sewage I happen to analyze, say Urbana, Champaign or any other sewage, is all the way from 100, 150, 200; some sewages with considerable trade wastes or very heavy sewages run on up to relatively enormous figures. Ordinary domestic sewage probably is in the range between one and two to 300 parts per million.

(Mr. Clausen) "I have here a sample of settled Chicago sewage" collected last night (September 23, 1940) from the settling basin of the Southwest Treat-
2269 ment Plant—effluent—just settled sewage plus about 18 hours standing. The sludge is essentially the same as activated sludge. Now if I pour Lake Michigan water into the sewage, doubling the volume (Counsel pours Lake Michigan water into jug containing Chicago sewage) "does that result in reducing the B.O.D. to approximately half its original value in parts per million?"

A. "In parts per million, yes."

Q. "If I would pour enough to double this, wouldn't that reduce the B.O.D. again to one-half?"

A. "Yes."

Cross-Examination by Mr. Clausen.

2270 If Lake water reduces the B.O.D. by dilution and if you start from Chicago with that additional water your additional B.O.D. would be about half what it is now in parts per million or pounds per day. Yes, you could reduce the B.O.D. to that extent by chlor-

2271 ination in parts per million. With enough chlorine the reduction would amount to 50% to 75%. Three parts per million wouldn't reduce it that much. I don't know that anyone has ever tried chlorination in any such amounts. I allowed for this factor of dilution in my computation comparing chlorine and Lake Michigan water. Dilution from tributaries greatly aids in the self-purification of streams.

The experiment just conducted (by Mr. Clausen) of
2272 adding double the quantity of Lake Michigan water to the amount of sewage he had in the other container would be comparable to carrying clean Lake Michigan water down to Lockport and there mixing
2273 it with the effluent from the canal at Lockport. That would be assuming that what you mixed it with there was the same sort of stuff as this sewage which was in one of these containers here. I didn't make any accurate calculations in arriving at this figure. This
2274 figure is so far from the amount of chlorine that is required in treating untreated sewage, partially treated, undiluted sewage, that it is my opinion that this amount of chlorine will be more reliable in ameliorating the conditions than the diversion. There again I point out that I was subpoenaed and prepared myself on the question of chemical precipitation on which I had previously testified. The questions asked in connection with chlorination were answered extemporaneously and then further checked as to the quantities in answer to the questions set by The Master. It would seem elementary that at twice the present flow in the Chicago Drainage Canal through the locks the time of the flow to the Kankakee River in the pool be-

low Brandon would be about half what it is now. It would depend on the cross-section of the channel. That is, assuming that the channel has a uniform rectangular cross section all the way down, then the answer is obviously yes; but as I saw it, it is twisty and the banks have different configurations, and so forth.

2275 Yes, I considered the effect of dilution either at Chicago or downstream as a factor in the maintenance of anaerobic conditions of the stream above and below Lockport. I have been Chemical Referee for Standard Methods of Water Analysis ever since the fifth edition was issued. A Chemical Referee is one to whom questions of new or changed methods is referred for opinion.

2276 It was because of my objection (to matter quoted by counsel from page 79 of the 6th edition) that this method was discontinued. I have heard of a man by the name of W. E. Adeny and I believe he is quite a reputable man and has written some very eminent books on the principles of the practice of dilution
2277 method of sewage disposal. I do not subscribe to the statement (read by counsel from Adney's book, 1928 edition, page 33). Furthermore I am credited with disproving the correctness of that statement by numbers of chemists who have studied that reaction.

2279 When I stated the method of using nitrate in the Standard Methods was discarded I meant as a method of determining B.O.D. it was discarded.

2280 I testified that each part of nitrogen per million is equivalent to almost 3.5 parts of oxygen.

2281 At Balston Spa we used 50 parts of chlorine per million. I have forgotten the flow.

2282 The chlorine applied to the water of the drainage canal would be by dry feed or solution feed, whichever method is most feasible under the condition. I don't remember the flow at Balston Spa. All I remember is the dosage. I would have to know the flow in order to figure the pounds. (Document handed to witness) That was half a million gallons a day which would be approximately 4,000,000 pounds and at 50 parts per million would be some 200, 250 pounds a day.

2283 That was for a 500,000 gallon discharge. In gallons I suppose that would be about one five hundredth the size of this plant.

2284 No, I wouldn't add lime if I supplied three parts per million chlorine to the water of the drainage canal. Lime would have a purifying effect. Yes, I believe, considering the exhibit produced by Mr. Ramey that the time of flow from Damen Avenue to Brandon Road is approximately five days, and considering the testimony of Mr. Andrew concerning the sludge deposit in the drainage canal and Brandon Pool, that three parts per million of chlorine applied at Lockport would be sufficient to give assurance that there would be relief from the odors of the drainage canal and Brandon Pool next summer. Yes, I have done work elsewhere on the application of chlorine to sewage. Chlorine was used in the experiment at Dearborn, Michigan.

2285 The process used was chemical precipitation with magnetite filters and then in part of the experiment

chlorine was applied to the effluent. This was a thirty day run under my supervision. Iron salts, lime and waste paper was added to the sewage. I do not believe that is used now. I do not have any data on the present operation at Dearborn. I made several visits to a plant at Atlanta Georgia. Chemical precipitation was
2286 the process used there. There was a clay or marrol or cement dusts of various sorts that were added. The chemical plant, I believe, was not installed at Atlanta. My study of the Atlanta situation was entirely limited to the performance of the experimental plant. I don't recall comparison between those results and the plan finally adopted. There were a number of problems involved besides the question of efficiency or effectiveness of the treatment. Clay or cement dust is not used in any process of sewage treatment now in operation that I am aware of. I have investigated the addition of chemicals to Imhoff tanks. The Atlanta experiment was carried out in an Imhoff tank—in the sedimentation portion of an Imhoff tank.

2287 I stated that the B.O.D. reduction by chemical treatment ranged from 60% to 75%. Those figures were collected on a weak sewage of about 113 parts per million B.O.D.—about the same as the Chicago sewage. That is as good as any reported results that I am aware of. Chemical treatment does not produce nitrates. If a chemical plant were installed at the West Side the effluent would not contain any nitrates unless the original liquid contained nitrates. The activated sludge process would be capable of producing nitrates. On my theory that nitrates are of value in a drainage
2288 canal and with the continued discharge of partially

treated liquors, the nitrates from the activated sludge process would have a decided advantage. In my original testimony I said there would be no advantage in the nitrates if the effluent were discharged into a clean stream. Talking about the conditions as they exist now in the Sanitary District Canal, activated sludge
2289 would be preferable. I gave an estimate of the cost of this additional chemical treatment of from $5 to $10 per million gallons for the cost of chemicals, and an over all cost, operating, and so forth, of from $15 to $20 per million gallons. The use of these chemicals would not be inconsistent with the use of the activated sludge treatment. Both could be done.

2290 If the cost of the chemicals might be $5 to $10 per million gallons, assuming the flow at the West Side of 475 million gallons, that totals $2375 to $4750 per day for the West Side. You would have to have additional equipment at the plant and some operating cost on that equipment. Roughly the operating cost would be equal to the chemical cost so we would have to double those figures.

2291 On these figures it would be $6000 to $8000 a day. That doesn't include any capital cost. I testified that dissolved oxygen would be used up by the sewage in the canal first, and then the nitrates. The drainage canal would become deoxygenated just as quickly if nitrates were present as if they were absent.

2292 I don't recall testifying that in the presence of sludge deposits in Brandon Pool nitrates would not prevent septic conditions. On page 1894 of the record I testified: "There would be odors present if there were nitrates present at the present time. If there al-

ways had been nitrates present in sufficient excess, I wouldn't expect odors under those conditions."

2293 I think there is another phrase in there—at times when bubbles arise from the bottom. That would be a necessary qualification for a correct statement. If nitrates were present in the liquid there would be no odor from the liquid itself. I know only from testimony that there are sludge deposits in the drainage canal. Biological self-purification of the water would continue while chlorine was present. Purification organisms aren't susceptible to any such quantities of chlorine as I have specified here.

2294 We have found comparatively recently that 20 to 30 parts per million of chlorine is not sufficient to kill the type of organism which grows in activated sludge and flocks such as were in that bottle, and so forth. For the last twenty years my time has been only two-fifths teaching water and sewage chemistry. I am a chemist—not an engineer. I have never designed a sewage treatment works. I have operated several experimental plants running as high as 100,000 gallons per day capacity, designed and operated them—not built them—for a year, two years.

2295 This was at Urbana in connection with the State Water Survey and so forth—experimental units. I have never been in control of chlorine applications at any sewage plant—I have in a water plant. I have never applied chlorine to stream cleaning under my personal supervision and observed the results.

September 13, 1940

Direct Examination.

2086 JOSEPH W. ELLMS, Commissioner of the Division
2088 of Sewage Disposal in the Department of Public Utilities, Cleveland, Ohio. I took charge of sewage disposal plants of Cleveland in 1923 and except for a per-
2089 iod of six months I have been in continuous supervision of those plants.

There are probably a number of methods available to the State of Illinois without an increase in the diversion of water from Lake Michigan by which there can be a decrease in the material which is now, or has been, entering the canal and passing into the pools farther down.

2090 Since this material undergoing decomposition in the canal and in the pools beyond might give rise to odors from decomposing organic matter, therefore the principal remedy is to keep out as much of that material as it is possible to keep out and to provide at the treatment plants as much purification as it is possible to provide. This might be done in a number of different ways. One, by the use of a larger quantity of air at the activated sludge plants which might produce a larger quantity of residual dissolved oxygen and also possibly by the presence of certain amounts of nitrates which become available if the dissolved oxygen were depleted. The ordinary sodium nitrate would provide about one pound of oxygen for every 1.77 pounds of nitrates or, to put it another way, one part of nitrogen as nitrate will produce about 3.4 parts per million of oxygen. The effluents of the sewage disposal plants at Cleveland have received treatment

with chlorine for the past 17 years. With the City of Cleveland discharging the effluent of its disposal plants
2091 into the same body of water from which it draws its water supply, it was used as a sanitary protection, to a certain extent, to the water supply. However, the orders of our State Health Department were that we should also use chlorine in connection with keeping the marginal waters in as clean a condition as possible during the bathing season; therefore the use of chlorine has been in force for this long period of time. The first plant was only a partial treatment plant, being an Imhoff tank plant; the second plant built five years later in 1928 was a trickling filter plant and an Imhoff trickling filter plant, and discharged its effluent to the Cuyahoga River. The latest plant is the activated sludge plant which is on the lake front the same as the Westerly Sewage Disposal Plant, that is, the partial treatment plant.

These original plants have all been enlarged and quite a number of different processes have been introduced in addition to what they were originally. We use chlorine at two of them, but the plant whose effluent is discharged into the Cuyahoga River is not treated with chlorine, but during the summer season—the bathing season—between the first of May and the middle of September chlorine is applied to the effluents of the two lake front plants.

2092 From the experience we have had in controlling odors it is my opinion that chlorine has a beneficial effect upon odor nuisance, particularly those odor nuisances that might be derived from hydrogen sulphide —development of hydrogen sulphide. We had a bad

case in one of our plants which received a trade waste from the rayon industry which contained large amounts of acid sulphates and sulphides. They were productive in our Imhoff tanks of considerable hydrogen sulphide and gave rise to a certain amount of nuisance in the immediate vicinity of the plant. The use of chlorine in the influent to the plant where it flowed through the flowing compartments of the Imhoff tanks reduced the amount of this gas to practically zero, but it didn't reduce the odor because the odor came from other parts of the same tank. That is, it was evolved from
2093 the so-called gas vents and, therefore, it did not produce any effect on the reduction of odors. We did find that there was a reduction in the sewage flowing through the upper flow chambers of the Imhoff tanks so that for a reduction or elimination of hydrogen sulphide chlorine is a very effective agent.

As to the effectiveness of the use of chlorine to control odors complained of in the Illinois Waterway and particularly at Brandon Road Pool I believe that they could reduce, perhaps eliminate, the odors from hydrogen sulphide that may be produced as a result of the decomposition of organic matter in the Brandon Road Pool. The continuous feeding of that pool, however, with partially decomposed organic matter is going to provide a continuing source of hydrogen sulphide which is, perhaps, the chief cause for complaints at, in and around that pool. As to the effectiveness as an ameliorating measure of keeping the sludge of all of the several sewage treatment plants out of the
2094 canal after January 1, 1941, I am firmly convinced that that is the hope of those operating the treatment plants

and I also believe that if such sewage solids are kept out, or diminished to a minimum there will be no further trouble in the Sanitary District Canal or any point downstream in the pools below. As to the effectiveness of the use of chemicals to the influent of the West Side Sewage Treatment Plant as a means of increasing purification and thus taking a load off the canal, the use of precipitating chemicals in connection with sewage treatment wouldn't increase the purification in the Imhoff tanks and would produce an effluent which contains somewhat less organic matter than what now results from plain sedimentation, but it would only be a partial ameliorating condition or provision if such chemicals were used. (See correction of this statement by witness at page 2296 of record). If the expectations of the operators of the Sanitary District sewage disposal plants are carried out I think conditions in the canal and in Brandon Road Pool in the summer of 1941 will be better than conditions were in the canal and in Brandon Road Pool in the summer of 1940.

2095 At Cleveland we have been using during the present summer (1940) what we call pre-treatment, or rather pre-chlorination and post-chlorination. I mean by that in this particular plant—well in both plants for that matter—that chlorine is applied to the influent of the plant as the term pre-chlorination and to the effluent in the plant as post-chlorination. At one plant we have been using 3 to 4 parts per million of chlorine in pre-treatment and in some cases as high as 7 or 8 parts in the post-chlorination treatment which,
2096 in this case, is the partial treatment Imhoff tank

treatment plant. We are using 2 to 3 parts at the other activated sludge plant and we are applying about 2 parts and getting very remarkable bacterial reductions in the effluent from the activated sludge plant. In all our plants we are using 5 to 6 tons of chlorine per day. In the course of a season when we had less complete treatment of the sewage, we used from 4 to 500,000 pounds at the plant where we had the least amount of treatment and about 2 to 300,000 pounds at the other plant and that was in the period of about 100 days so that the chlorine contracts have generally run from about a million to a million two hundred thousand pounds for a season, because it wasn't used at any other season except during the bathing sea-
2097 son. The quantity of sewage passing through those two plants would run about probably 125 million gallons a day. That is about one-sixth the 900 million gallons at the West-Southwest plants here.
September 24, 1940

Cross-Examination.

(Joseph W. Ellms)

2296 May I correct one error in my direct testimony. On page 2094, the answer to the question, second paragraph, "The use of precipitating chemicals in connection with sewage treatment", it says "wouldn't". Of course, it means would increase the precipitation in the Imhoff tanks. It is "would" of course, because chemicals added prior to passage to the Imhoff tanks would increase the precipitation.

The water purification plant at Cincinnati is a plant
2297 of 112,000,000 gallons capacity daily. At the time I operated that plant between 1907 and 1918 we used sulphate of iron and lime for coagulating the river water and we used from a grain and a half to perhaps a grain and three-quarters of sulphate of iron and some three-quarters of a grain, probably, of lime per gallon. In round figures that would be in the neighborhood of 286 or 300 pounds per million gallons. If we treated 60 to 70 million gallons it would be 60 times that amount. It would be in the neighborhood of 9 or 10 tons, I think, if I have the correct figures in my head. Those chemicals were applied in a solution or suspension. The sulphate of iron was applied as a solution and the suspension of lime was run into dilution tanks and changed to a lime water solution.
2298 We did not employ a mixing basin. We had no mixing tanks. The chemical solutions were applied to the raw water just prior to their entrance to the settling basins. We had two coagulating basins into which the treated water was passed and through which it was passed from there to the filters. We had at this plant 28 sand filters, each having a capacity of about four million gallons a day on a basis of 125 million gallons per acre rate of filtration. The valves were operated by electric motors. Other than that the usual
2299 methods of operating were the same as in all rapid sand filter plants, with the exception, perhaps, that there was first introduced a high velocity method of washing the sand filters by sending the wash water up through the sand bed at such a rate that the sand was floated. Yes, I think it is customary now days to

provide both mixing and coagulating basins ahead of the sedimentation basin, and one of the Cleveland plants was provided with so-called baffled mixing channels which took and flocculated the treated water prior to its discharge into the settling basins. On the other hand the plant that was built while I was Consulting Engineer for the city did not contain and pre-mixing channels but did contain what was known as the hydraulic jump mixing flume which gave a very rapid mixing action to the water to be treated. At both filter plants in Cleveland we have quite ample storage for our chemicals. We have about 1300 tons capacity at one plant for sulphate of alumnia and at the other plant there was very large bins provided for the lime and sulphate of iron which were first used
2300 there but which are not now used, since we have substituted sulphate of alumnia for the iron sulphate and lime which we used between 1918 and 1921 or '2. That would take care of probably three months supply. The capacity of the Baldwin plant at Cleveland is 165 million gallons per day. In that plant we used a solution feed for the sulphate of alumnia by dissolving the solid material and diluting it with water in tanks and feeding it on a solution base. That is the only chemicals used except chlorine. Approximately 4 to 5 tons of chemicals were used per day. This plant did not have a mixing basin.

2301 As I explained before it contained this hydraulic jump mixing flume and following that we had settling basins. These were installed because they were regarded as necessary. Expressed in days for which the supply is adequate there is four months storage at the

Baldwin plant for chemicals. In a general sort of way, I suppose, the application of chemicals such as lime and ferric chloride to sewage on a large scale would follow along the same general lines as for water purification; that is, as to the methods of applying and handling chemicals and storage and installation of
2302 mixing and coagulating devices to be used, or the effectiveness of the amounts of coagulating chemicals that might be applied upon the particular sewage being treated.

In my practice as a water works engineer the largest amount of chemicals I have had to provide per day, I do not believe could be over ten tons. In my practice I have applied chlorine to water as a solution of the chlorine gas in water. It is applied to sewage in the same way. At one of our plants we have also applied it as a gas combined with air, more for the purpose of separation of grease and the suppression of odors rather than for its chemical effect otherwise. Yes I have used the dry application direct, except as I just mentioned in connection with air. Otherwise it has always been by passing the gas into the water and dissolving the gas and forming what we call chlorine water.

2303 The difficulty, I think, of applying dry chlorine direct is the liability of gas escaping to the surface of the water, particularly where depth at which it is applied is insufficient to dissolve the gas prior to its rising to the surface. There has been some indication of that in the plants that we are operating, particularly in conduits which were shallow and where the gas apparently escaped to the atmosphere before it could be

dissolved in the sewage. Yes, I have in the application of dry chlorine, run into the formation of so-called chlorine hydrates which would tend to clog up the outlets of the distribution grid. Under low temperature conditions that is quite liable to happen. It, however, is usually quite easily controlled by heating the water used to dissolve the chlorine gas. We are applying chlorine at two sewage plants only in Cleveland and we are applying it to the influent to the plants in each case and to the effluent as well. The quantities applied to the influent will run from 3 to 5 parts per million and to the effluent, in one case, 4 or 5 parts per million, and in the activated sludge plant effluent only 2 to 3 parts per million.

2304 One part per million is equivalent to 8.34 pounds per million gallons, so that any of those figures multiplied by 8.34 will give the number of pounds per million gallons. In Cleveland it is applied for the purpose of preventing any odors which may arise from sewage entering the plant and in the effluent from a plant it has been applied to keep down the pollution of the lake water in the vicinity of the bathing beaches of Cleveland and that has been carried on through about 100 days during the summer months, or during the bathing beach season. To protect the men that put chlorine into the water, we have always provided water with hose connections so that if any break occurs it can be flooded with water immediately, and the men are provided with masks so that they are able to work in an atmosphere that contains some chlorine.

2305 We provide special ventilation in some of the buildings so that fans will suck out air that may be contaminated with chlorine gas. When I testified previously as to the value of chlorine in ameliorating the conditions in the Joliet Pool I don't think I knew exactly the time elements of flow from the Stickney Plant—that is, the West Side Plant—to Brandon Pool. I assumed it was in the neighborhood of 3, 4 days. I don't think my answer would be any different if I assumed the time to be from 4 to 4½ days to Lockport and then three-quarters of a day from Lockport to Brandon Pool or Brandon Road. The Westerly plant at Cleveland was a partial treatment plant and consisted only of screens and grid chambers and Imhoff tanks and still is operated in that way except that the sludge now is really digested sludge taken from separate digestion tanks to which the raw sludge has
2306 been pumped from the settled sludge in the Imhoff tanks. In other words at the present time the Imhoff tanks are not operated as Imhoff tanks; they are merely settling basins through which the raw sewage is dropped out and pumped to the separate digestion tanks with floating covers, which enables us to obtain the methane gas which is needed for incineration and which can be collected from such tanks and cannot be collected from the Imhoff tanks. For a number of years the sludge from that plant was discharged into Lake Erie through an outfall conduit. The reason for that was that we had no other place to put it. We had no treatment of that on land; there was no area where we could treat it. In later years we arranged to handle that sludge as you are doing now.

2307 It took us 14 years to do that. For that period of 14 years the digested sludge was discharged about 2500 feet out from the plant through the outfall into the lake. No 5-day B.O.D. determinations have ever been made as routine tests on sludge at the Cleveland sewage works. I do not know of any sewage works in which 5-day B.O.D. determinations are made on sludge. Prior to the installation of the Southerly plant in Cleveland the sewage in that plant was passed through Imhoff settling tanks and the effluent from the plant was treated on trickling filters. The sludge was dried under glass in sand drying beds, except that which we were unable to handle on the drying beds. Prior to the operation of the sewage works the sewage went into the river.

2308 The so-called Southerly interceptor which collected sewage from the southerly district was completed at the same time that the treatment plant was built so that all the sewage which has come through that Southerly interceptor so far as I know has always been treated. Before they had the interceptor the sewage flowed through the various trunk sewers to creeks or to the Cuyahoga River. The river was pretty foul, there is no question about that. I wouldn't be a bit surprised if it contained sludge deposits, although I don't know it. That then washed out into Lake Erie at time of storms. Lake Erie is used as a source of drinking water for Cleveland.

2309 The first intake was directly north of the river mouth. The second intake was about a mile and a half from shore. The third intake was about four and a half miles from shore. Those large basins in which

sedimentation takes place at filter plants like Cincinnati or Cleveland, or in which sedimentation is accelerated by coagulating chemicals, must be drawn down and the sludge washed out under hose pressure; two under drains carry it away to some disposal plant. In addition to these hydrants and fire hoses we also put men in with rubber boots to squeege or shove the sludge along to the outlet of the basin. I don't know that any measures were taken to relieve the nuisance in the river prior to 1928, that is, prior to the time when the plant started operating.

2310 The efforts of Cleveland and the general metropolitan district has been such as to coordinate a series of trunk sewers and interceptors in such a way that the collected sewage might be taken to the three plants which now dispose of it, two on the lake front and one in the Cuyahoga River Valley on the Cuyahoga River. The problem of the low level sewage along the Cuyahoga River is not as yet entirely settled. Not even designs have been made for interceptors which will have to be built to collect the sewage which is produced in this industrial area. Chlorine was never applied to the river that I know of, or to the sewers entering the river. The only application of chlorine to the sewage I know of has been at these plants since about 1922. Yes, we applied chlorine to the effluent of the Southerly plant during one year in the summer months because of the septic condition in which the sewage reached the plant and in order to reduce odor troubles we applied chlorine to the raw sewage as it entered the plant.

2311 That was for controlling odors in the plant and not in the river. Construction was commenced on the Southerly Plant about 1925 or 1926. It was completed in 1928. I am not sure when the first contract was let. There was some land bought down there and some excavation made prior, I think, to 1925 or '6, but I wouldn't be able to say just when. It was finished in the late summer of 1928. The approximate cost of the Southerly Plant was three and a half million dollars. We have a chlorine plant at the Easterly activated sewage sludge plant in Cleveland which has six 4,000
2312 pound units for the evaporation of the liquid chlorine and its conversion into a solution with water. These units consist of an orifice apparatus and is known as the vacuum type of chlorine feeder. The modern machines are rather elaborate in their controls. A great deal or hard rubber piping has to be used on account of the corrosive character of the solutions and the gas itself. The chlorine that is applied in this particular plant is actually some five or six hundred feet away. We purchase it in ton containers; that is, in cylinders containing one ton of chlorine. These are placed on a large platform scale and the quantity of feed or rather the gas pressure in these cylinders forces the liquid a distance of some several hundred feet and to a higher elevation into the evaporators, so-called. These evaporators being steam-heated keeps the entering liquid in gaseous form because it is being forced up to those machines as a liquid. The solution then is fed at the various points at which we apply it, and that is carried in hard rubber piping, I guess, to the points at which we apply the gas.

2313 I think it would be very desirable to have a plant that is going to use 25 or 50 to 75 tons under laboratory control. I should think it best to have a man—a chemist—on the job all the time. In mixing water with chlorine you would not necessarily have to have drinking water. We could use the best effluents from our sewage treatment plants, like the trickling filter or the activated sludge plants. The only thing that has to be avoided is suspended material which might clog water orifices or upset valves or something of that kind. It needs clear water, that is about all it needs. If the water were partially polluted there would be a certain amount of demand on chlorine.

2314 If the object were to obtain at the earliest possible time the use of a chlorination plant under municipal conditions as applied to Cleveland or the Sanitary District of Chicago, ready for application of, say, 50 tons of chlorine per day, and contracts were diligently prosecuted, I imagine that that can be done in the course of six or seven months. That is from the time when the contract is let. I imagine you would want a couple of months to plan the work and advertise for bids and let contracts. For a 75 ton plant it would require, perhaps, a month or a month and a half longer.

2315 A chlorine plant to apply 50 tons per day could I think be built and equipped for a sum considerably less than $300,000. That would be everything. If deliveries could be depended upon enough chlorine storage would be provided by the amounts used in 15 or 20 days. I don't look at this problem in the same way that I would look at a problem involved with a drinking water supply. This is a preventive measure that

is supposed to avoid odor nuisances and gaps in treatment, I doubt, would have any very noticeable effect unless there was too long a period.

2316 Chlorine could probably be obtained cheaper in either 15 or 30 ton tank cars. I have used 30 ton tank cars but generally we allow smaller quantities which we use at the sewage plants or at the water plants. We use the 15 ton tank cars. I don't know of any works in the United States using such quantities as you have mentioned for either water or sewage. If you used the tank car as a storage while it is being applied it would, of course, be necessary to have the railroad siding close to the point of application. On the other hand there is no reason that tank cars can't be

2317 emptied into permanent tanks set at some point where the liquid could be stored and with the gas pressures which exist above the surface of that liquid they might be able to force the liquid chlorine to quite some distances. In fact, that is what we do at the Easterly sewage plant at the present time. Storage tanks would probably be required as a necessary part of a 50 ton or a 75 ton plant since tying up tank cars is rather an expensive proposition for the manufacturers, and I doubt if they would care to enter into contracts where those tank cars would be held for any length of time, although those tank cars are leased by us without any demurrage charges, so that it is possible if you use the tank car very fast and at a point where the chlorine could be drawn directly, a matter of holding in use these tank cars there for storage tanks from which to deliver the chlorine would not be prominent.

2318 The only guide I have on the cost of a plant sufficient to supply 50 tons is the chlorine plant at our Easterly plant. That has a capacity of 12 tons a day and cost about $85,000. Of course if it is in direct proportion for a 50 ton plant it would be four times that amount which would be over $300,000, but that has some features that, perhaps, would not be required for a temporary plant such as might be built or made use of in connection with chlorination of that Brandon Pool or the waterway in general or at the plants themselves, so I said perhaps less than $300,000.

2319 The Cuyahoga River, about which I was examined, is a small stream. It has a flow that ranges probably all the way from 4,000 to 40,000 or more cubic feet a second. Back five or six miles from the mouth it is really a sort of an estuary—a lagoon of Lake Erie. Above that point it passes through a country district and receives some pollution from an effluent from a sewage plant at Akron, Ohio. So that it isn't entirely a clean stream above the point of discharge of the effluent from our Southerly plant, which is about 9 or 10 miles from the mouth of the river. I don't know exactly, but the river must be some 40 or 50 miles in length, total, but it is a very crooked stream and the larger vessels have a great deal of difficulty getting up the river. We have been making some improvement in cutting off bends in the river in the last two years and changing bridges, but the navigable portions at present, even for the large ore boats, is only about five miles from the mouth. The nuisance, as far as the Cuyahoga River is concerned, extends as

2320 far as the metropolitan district of Cleveland—a dis-

tance of about 10 or 12 miles. For that distance there was a nuisance condition resulting from the discharge of untreated sewage into the stream and also from trade wastes. That nuisance condition still obtains today. I don't think it is very much different today from what it has been. Last week we took a series of samples of the river.

2321 There was dissolved oxygen in all the samples taken from above our Southerly plant and below the plant for a distance of about 4½ miles. From that point on there was no dissolved oxygen in the water at all, another distance of 4½ miles. Sewage treatment has improved in Cleveland in recent years, particularly on the lake front. We have three districts called, Westerly Sewer District, Easterly Sewer District and the Southerly and combined with the Southerly what is now known as possibly the Southwesterly. Now these do represent an increase in the treatment and they represent a decrease, probably, upon our general lake pollution, but the valley district has never been provided with any interceptors so that the sewage from these industries and from some of our trunk sewers still flows into the creeks which discharge into the river or into the river directly. The effluent from the

2322 Southerly plant goes into the river. That effluent is from completely treated sewage, but the other sewage to which I have referred, which does not come through our plant, is completely untreated. Week before last I was visiting with Mr. Howson the Brandon Pool and was down to the dam at the lower end of the pool. That is all I have seen of the conditions excepting what can be seen out around here. I stood on the

gates at Brandon Road Pool and crossed the bridges at Joliet. From that examination, I imagine looking at it, that the Brandon Road Pool is in better shape than our Cuyahoga River. The Cuyahoga River is 300 or 400 feet wide, perhaps wider, I don't know just how wide. The velocity over the distance we are talking
2323 about is very low, indeed, because as I say, up to four miles, as far as navigation goes, about all that ever flushes it out is a flood in the stream from the back country, that is merely a lagoon of the lake. From the few (samples) that we took last week the B.O.D. of the water in that stream near the plant range from 3 to an average of about 15 or 18 or 20. The lowest ones occur apparently very close to where considerable iron pickling from the steel industry gets into the stream which, of course, absorbs all the oxygen immediately. It isn't a biochemical oxygen demand; it is a chemical satisfying of the ferrous iron which is present in the pickling. That would not exactly afford a satisfactory comparison with the Illinois Waterway at Joliet or the Brandon Road Pool because in this case, I think that the bio-chemical oxygen demand and the low dissolved oxygen is more likely
2324 to be due to industrial wastes, a larger proportion of it at least, than to raw sewage. I don't think that the odors down the Cuyahoga River are so noticeable. Of course it is not a residential district at all; it is an industrial district entirely. While there may be more or less gas, I guess there is more or less sludge in the lagoon or the lower portions of the river, there is little chance for absorption of oxygen from the air on account of this extensive oil slick and probably there

is some gas-lifted sludges from the bottom deposits. I imagine there is some accumulation of sludge in that stream, although I couldn't say. It has to be dredged every few years in order to keep the draught for large vessels going up. That stream runs right through the business district of Cleveland and the industrial district south of it. I referred to it as a foul stream some
2325 time ago in my testimony and I don't think I withdraw the name. The trouble there is due to a combination of sewage and industrial wastes and oil scum. I hardly think you could justly draw any comparison between that stream and this waterway. As far as your canal and your waterway are concerned you are dealing entirely with a large sanitary sewage flow. Pollution and the deoxygenation of your water is due to organic matter. I don't know to what extent trade wastes enter into the situation but it is always my impression that they were minor; that is, I mean iron and steel trade wastes, although the starch industry and other industries of that kind do add a heavy organic load.

2326 I wouldn't consider the Cuyahoga River a health menace unless the people insisted on bathing in it, or something of that kind. It is a foul stream as far as these trade wastes that enter it and so far as the oil and the scums from the refineries. It has ruined its surface and they lay there in a stagnant condition. I would not consider the Sanitary District Canal a health menace in the way it is used, so long as it is not used for drinking or for bathing.

2327 If it were possible to do so I would say it would be advisable to apply chlorine in the stream or canal

before septic conditions had developed, because very much less chlorine probably would prevent septicity if it could be done before rather than after. If chlorine is to be applied to the Sanitary District Canal, I think it would be very helpful if it were applied in several places rather than one. I think it would be more effective.

2328 Q. (The Master) "If it (chlorine) wears off in half an hour to an hour as some testimony here given, as I understood it, indicated, what is the advantage of applying it upstream, say at the Southwest Side Plant instead of waiting to apply it at Brandon Road Pool.

A. I don't know whether I can explain to you exactly what I think takes place when chlorine may be applied to a liquid that contains organic matter. My theory is that the application of the chlorine to such a liquid as a sewage probably kills off a certain amount of the organisms which are at work to produce septic conditions. It may not kill off, and probably does not kill off, all of these organisms which are productive of oxidation conditions through bio-chemical activity, so that you may have a condition in which there is an arrest of the decomposition of organic matter due to the addition of chlorine to the sewage and to its effect that it may have upon certain organic compounds, and yet there still continues an activ-
2329 ity which is along lines of oxidation which would have a normal effect to reduce the biochemical oxygen demand. Take in the case of trickling filters; you can apply chlorine to trickling filters and yet you will have oxidation conditions in your effluent, even probably nitrites and nitrates."

The way I look at it, the administration of chlorine would have a tendency to arrest the operation of the poisoning conditions, the septic conditions. If it arrests it to a certain point and then wears off—ceases to be operative—it still has arrested it up to that point —to a half way point and then the chlorine ceases to be effective, but still you have accomplished something. The septic operation is half dead. That would be a reasonable method of putting it.

May I briefly recite an experiment that I carried on some 30 years ago? I took a dozen or more samples of water, determined the number of bacteria which they contained, and then I treated those ten or a dozen beakers with different amounts of chlorine, ranging
2330 from one-tenth or two-tenths of a part up to several parts per million chlorine. Then I allowed those to stand with cotton stoppers in them so they couldn't get contaminated with the air, and opened them one-half hour to an hour, two hours, three, four, forty-eight hours, up to ten days, and here is the general result which was obtained: That whenever the residual chlorine in that water disappeared, then bacterial forms began to appear, although up to that time, so far as our culture methods were concerned, there were no bacteria present, and yet there they came to or whatever happened to them I don't know. When they revived I was no better off than if I had never put in the chlorine and the net result would be that I was better off only while the chlorine was operative. That is true as to odors also.

2331 If you can prevent septic conditions in the pool you won't have odors.

TESTIMONY OF LOUIS F. WARRICK.

2100 My name is Louis F. Warrick and I am the State Sanitary Engineer of Wisconsin. I was graduated from West Virginia University with degree of bachelor of
2101 science in chemical engineer. I obtained a degree of master of science at Cornell University. In 1924 I was Assistant Sanitary Engineer of the State of West Virginia. In 1925 I went to Wisconsin to become Assistant State Sanitary Engineer. I became State Sanitary Engineer of Wisconsin in 1927.

2102 I have had occasion to make use of chlorine in water purification and sewage and industrial waste treatment. It has been commonly employed for a disinfection of sewage and has been used very extensively
2103 in the water purification field. Chlorine has been used to a considerable extent in the prevention or reduction of odors and has been very beneficial in overcoming serious nuisances. Chlorine does play a part in basic stream clean-up program in the State of Wisconsin.
2104 When I came to Wisconsin the sewage from our municipalities was discharged through 60 sewage treatment plants. Less than 30 per cent of the population served by public sewers in 1925 passed through sewage treatment plants. We now have 89.7 per cent of the sewered population of Wisconsin taken care of by at least primary or the basic chlorine treatment. Sixty-four per cent of that population is now receiving complete treatment. There are a number of states in the Midwest, Minnesota, Iowa, New York and other states that have employed chlorination as a part of their programs of stream clean-up.

2105 I have attended all of the present hearings before the Special Master in connection with the order of the Supreme Court of April 3, 1940, and I have heard the testimony of Dr. Buswell, Mr. Howson, Mr. Enslow and Mr. Ellms relative to the effectiveness of the use of chlorine in ameliorating or remedying the conditions complained of in the Illinois Waterway and I agree with their conclusions. I believe from experience that there would be a decided beneficial effect
2106 in the application of chlorine to the Illinois Waterway. It is my opinion that an increased amount of air at the several activated sludge plants in the Chicago Sanitary District as an ameliorating measure would have a beneficial effect. I have had occasion to make studies of the pollution conditions in the streams in the State of Wisconsin, and it has been
2107 my observation that water that has been depleted in oxygen through the introduction of wastes, when such waters pass through rapids or cascades, that there is an introduction of a very appreciable amount of oxygen. It is very common to expect that from 50 to 75 per cent of the saturation value at those temperatures may be realized through the passing through rapids or cascades or aeration spillways. I believe that the use of the cascade near Lockport at Stony Gates as ameliorating or remedying the conditions complained of would be beneficial from the point of view of the introduction of additional oxygen.

2108 I think the discontinuing of the discharge of sludge into the Sanitary Canal as an ameliorating measure is probably the most important of the items that have been brought up. A well receiving surface drainage

2109 or seepage is regarded as unsafe. Any well in the vicinity of the City of Joliet, Illinois used as a source of domestic water supply, if it receives any seepage from the Sanitary Drainage Canal or from the Brandon Road Pool, would be regarded definitely as unsafe. It is my opinion that there is no measureable difference in the hazard to the health of the people using wells in the vicinity of Joliet as a source of domestic water supply if such well receives seepage from the Sanitary Drainage Canal or Brandon Road Pool whether the flow is 1500 cubic second feet or 5000 cubic second feet.

LOUIS F. WARRICK.

Examination by the Master.

2110 The quantities of chlorine used in one treatment plant roughly would be from three to five parts per
2111 million gallons for a treated effluent, from 5 to 10 parts for a primary treated effluent with settleable solids removed and from 10 to 20 parts for a screened or raw sewage, possibly having a still higher require-
2112 ment in order to disinfect or control odors. In order to make those figures comparable to other figures given here by other witnesses you would multiply by 8-1/3.

LOUIS F. WARRICK.

Direct Examination.

2119 In the bracket 3 to 5 parts per million for completely treated sewage, this is equivalent to from 25 pounds to 42 pounds of chlorine per million gallons.

In the bracket 5 to 10 parts per million of chlorine, this is equivalent to 42 pounds to 83 pounds per million gallons. In bracket 10 to 20 parts per million of chlorine for screened or raw sewage, this is equivalent
2120 to 83 pounds to 167 pounds per million gallons. These amounts are necessary for disinfecting and deodorizing these effluents. The strengths of sewage will determine largely the chlorine demand. Generally speaking the chlorine demand roughly parallels the oxygen demand. The amount of chlorine for counteracting the effect of hydrogen sulphide is in ratio to their combining weights.

LOUIS F. WARRICK.

Cross-Examination.

2226 I have been active in state sanitary engineering work since June 1924. A chief engineer of a state board of health is both an executive and an advisor.
2227 My first visit to the Lockport Power Plant and Brandon Road Pool was in 1927 or 1928. It was an incidental trip. It is true that if there was a velocity
2228 of a half a foot per second or less in the main channel, deposits would occur under present conditions. Such deposits would exert an oxygen demand and chlorine demand. If chlorine were introduced at the Southwest Works in the effluent in the amount of three parts per million several facts would enter in as to how long such a dose would last. The chlorine demand that existed at the time; the amounts that would be taken up by the sludge is influenced to a
2229certain extent by the temperature. It might last a

half hour. It is impossible to state unless you know
2230 the specific conditions existing at the time. Possibly
2231 under summer conditions that chlorine residual would exist half an hour to an hour. The most important would be removing sludge at the source. As an ameliorating agent, chlorine might be applied effectively in addition to overcoming odor nuisances and the like. Chlorine is not applied at Milwaukee for disinfection of the effluent. The effluent is diluted in Lake Michigan at considerable distance from the point of intake
2232 of the public water supply. Madison, Wisconsin has used chlorine at the sewage treatment works for sludge conditions; incidentally, odor control. In reports on sewage plant operations nitrate oxygen is not included in the percent reduction of B.O.D. I do not permit any sewage plant operators to report the oxygen in nitrates as part of the reduction of B.O.D.

2233 Redirect Examination by Mr. Naujoks.

With reference to a 50 to 75 per cent saturation restored to the water by aeration, cascades or spillways we have had occasion to determine how much oxygen was restored to the streams above and below points of aeration. There has been considerable attention given to cascading, aeration spillways, to increase the
2234 turbulence of the water in order to permit rapid absorption of oxygen in the atmosphere. In the initial survey that was made, there was a considerable depletion of oxygen due to ~~the sewage~~ and industrial wastes from the Twin Cities that in passing downstream

2235 toward Hastings rapidly removed the oxygen from the water. The results of these tests show that as the oxygen in the water above the dam becomes more nearly depleted, the rate of restoration of the oxygen to the water goes up. The head above the dam was the most important factor. The beneficial effect of that aeration is brought out in the oxygen profiles of the
2236 stream, an oxygen profile being the dissolved oxygen taken at different points progressively downstream and a line drawn through those points gives you an oxygen profile of that stream. The usual procedure is to lower the pool level since the navigation season is closed. This oxygen recovery is shown very markedly by the sudden rise in the dissolved oxygen content at the station below Hastings Dam.

Examination by the Master.

Chlorine administered at the points to which Mr. Clausen referred would wear off in half an hour to an hour. During the summer conditions the chlorine is taken up at a more rapid rate and you would have
2237 a very rapid depletion of the available chlorine as measured by the residual chlorine test as the flow proceeded downstream toward Lockport. In order to make chlorine constantly effective as a deodorizer you would have to apply it at several points in order to maintain a continual residual chlorine content, depending upon the flow. You can chlorinate below the amount necessary to take care of the chlorine demand and have an ameliorating effect. An example is a slaughterhouse in a residential neighborhood. We heavily

2238 chlorinated at the slaughterhouse, added enough to suppress the odors through that area until it reached a larger diluting body of water and that solved the problem. That was considerably less than the chlorine demand. Chlorine demand is the amount of chlorine that is taken up, as a ten-minute contact period of the chlorine with the particular waste or water. The amount that is used up is the chlorine demand. The effect of the chlorine dose as a deodorizer may continue beyond that period. There is no precise way of determining how much beyond that period the effect
2239 would continue. It would be just a matter of the expert opinions as to how much chlorine would be required. It would depend upon the strength of the pollution, degree of pollution in the stream.

Recross-Examination by Mr. Clausen.

It is difficult to state exactly to what extent the operation of cascades at Lockport would ameliorate
2240 conditions in the Brandon Road Pool. That would depend upon the amount of oxygen that is restored through the cascading. If the percent saturation at the point of cascading is around zero, then it is perfectly possible to put in as much as 50 to 75 per cent of saturation by that cascading procedure. In summer conditions your per cent of saturation is computed based upon a figure of about eight and a half to nine parts per million as being 100 per cent saturation and the amount restored would be 50 to 75 per cent of that amount, and it is difficult to state just how long

that would last. The oxygen resources and pollution of the Mississippi River are given in Chart 4 on page 29, but it is not in parts per million. At the Hastings Dam the five day B.O.D. was around 7.95 in August and September 1934. During July, August and September 1933 the oxygen added by aeration at the dam averaged 4.3 parts per million, equivalent to 39.800 pounds per day.

About 7.8 parts per million of dissolved oxygen was present below the spillway of the Hastings Dam. Some of that might have been in there originally when it came to the dam. The five-day B.O.D. at Lockport for the month of June last summer was 25 to 30 parts per million. With so much greater B.O.D. at Lockport the dissolved oxygen would rise about 7.8 parts per million. It might rise above that by aeration by cascades. The results indicated in the book show that with the 18 feet of head at the Hastings Dam there and zero dissolved oxygen in the water, that there was restored approximately 75 per cent saturation. That is summer conditions. Assuming you have a B.O.D. of 25, it would be in the ratio of whatever the amount of oxygen you restored was to that 25 parts per million of B.O.D. It would be hard to state how long you would be able to hold any dissolved oxygen through Brandon Pool after it has left this proposed cascade. I doubt whether it would be carried through Brandon Pool. The sludge deposits would utilize dissolved oxygen contributed through cascading. The application of chlorine to the effluent from the West Side Plant would ameliorate conditions in Brandon Road Pool to the extent to which it would reduce the oxygen demand, to the extent to

which it would retard the biological action below the point of discharge. I think from the standpoint of Brandon Road Pool a much more beneficial effect would be the chlorination at or above the pool. I could give no exact computations. It would be beneficial to the extent to which the oxygen demand is reduced and the biological life retarded.

Examination by the Master.

2245 It is my opinion that cascading would contribute some oxygen. How much it would contribute and to what extent that would be effective in removing the odor and conditions complained of is a matter of speculation, with the exception of past experience to indicate that oxygen put in has a beneficial effect in increasing the dissolved oxygen at progressive points
2246 down-stream. The effect of the oxygen or the amount of oxygen it would contribute at Brandon Road Pool would help to the extent that it would put that much more oxygen in there to take care of the oxygen demand of the sewage and the wastes. You couldn't positively state that that in itself would correct or would completely overcome the oxygen demand. It would simply satisfy a portion of that demand that you expect during the summer conditions with sludge pres-
2247 ent in that pool. It would be beneficial to put chlorine in down near Lockport and Joliet, to the extent of
2248 retarding the rate of decomposition on the way down. Even though there is no available chlorine showing up by tests, there is a beneficial action. It has also been

shown by experience that chlorine applied ahead of septicity has reduced the amounts of chlorine, the overall amounts that have been necessary in controlling nuisances. I think the application of chlorine at Brandon Road Pool or immediately above would be the most beneficial as regards conditions at Joliet and Lockport.

Recross-Examination by Mr. Clausen.

2249 I would think it would be advantageous to put in chlorine at several places above Brandon Pool.

3385 LOUIS F. WARRICK.

Direct Examination by Mr. Naujoks.

3386 Opponent's Exhibit No. 16 is an enlargement of Opponent's Exhibit No. 8 showing a section of the Sanitary District Canal taken from near the south end or south bank of the canal at U. S. Highway 45 bridge. This picture was taken on the afternoon of September 24, 1940, at 1:40 P. M. Central Standard Time. The picture is practically from the identical location where the picture was taken by Mr. Schwob of the Illinois State Department of Health, which I believe was testified to as being the year before, during the summer of 1939. This corresponds to Illinois Exhibits 58 and 59. It will be noted that at the time this picture was taken, that there was no scum or sludge in evidence over the surface of the canal. (Said exhibit marked "Opponent's Exhibit No. 16" was thereupon offered and received in evidence.)

September 26, 1940

Direct Examination by Mr. Naujoks.

2635 WILLARD L. BERGMAN,

2636 2748 Mildred Avenue, Chicago, is a chemist employed at Rush Medical College, Department of Toxicology and Medicine, located at Chicago. I have been a cehmist for about 30 years.

I have made analysis of the air in the vicinity of Joliet or Lockport along the Illinois Waterway. I made these tests on August 3, 1940. In my tests or analyses of the air I tested for hydrogen sulphide. One test was made at the 9th Street Bridge in Lockport, Ill. This test was taken under the bridge. I took a three-gallon sample of air, three separate gallon samples.
2637 Another test was made at the Jackson Street Bridge in Joliet, Ill. That test was taken alongside the bridge. You couldn't get under it close to the water. I have to take that on the outside, on the concrete embankment. My tests of the air taken at those places disclosed no trace of hydrogen sulphide.

By the Master.

There was no reason for selecting those particular points. I was told to go to Lockport and Joliet at the Sanitary Canal and get some samples of air. I located the canal at Lockport. I found a little house where the caretaker of whatever you call him was and I asked him whether that was the Sanitary Canal. He

said "Yes" so I said "Well, here's where I take a sample". The same procedure at Joliet.

I did not go to Brandon Road Pool below Joliet.
2638 I discerned no odors, except just an odor of oil—lubricating oil. The temperature that day was pretty hot—I will say about 90 or so.

September 27, 1940

WILLARD L. BERGMAN (Recalled)

Cross-Examination by Mr. Wallenstein.

2711 The tests made at the Ninth Street Bridge in Lockport and at the Jackson Street Bridge in Joliet were the only tests I made. That was on August 3, 1940. We
2712 went along the pool a little bit, but not very far down. We went down to the bottom at Lockport and took a test. The reason for picking these bridges was for identification. I wouldn't know how to identify any other spot along there. The only odor I could perceive was an engine oil odor, as though from motors or something of that sort. I couldn't detect any sewage odor at all there from my sense of smell. There were no gas bubbles on the water that I saw and that was true of both places where I made my tests.

The method of determination used—well, I bubbled this air through an N10iodin solution and titrated it back with the thiosulphates.

2713 The analysis was completed at the laboratory in Chicago. Perhaps two and one-half hours elapsed between the collection of the sample and the analysis. That was when we started. The analysis was com-

pleted about four hours after I got back. When you bubble pure air through N10 iodin, the loss of any iodin depends upon how fast you do it. If you bubble it through fast you may get some splashing there. This was bubbled through a wash bottle and very slowly —perhaps two bubbles a second or something like that.

2714 Under those conditions the loss of any wasn't perceptible.

2717 The concrete abutment from which the test was made at the Jackson Street Bridge is, I would say, 8 feet above the water.

2720 The tests I made at Joliet at the Jackson Street Bridge and at Lockport at the Ninth Street Bridge, represented fair and accurate tests based on my thirty years' experience as a chemist. The instructions 2721 when I went down there was to get some samples of the air and test them for hydrogen sulphide. I was told just to go to Lockport and Joliet, so I had to find some place of identification. I selected the points —I wasn't with Mr. Jenkins.

September 26, 1940

Direct Examination By Mr. Naujoks

2659 DR. WILLIAM D. McNALLY. I am a graduate of the University of Michigan; taught in the University of Illinois. I am a graduate from Rush Medical College, affiliated with the University of Chicago; post-graduate work in Vienna; have been teaching at Rush Medical College since 1913; was coroner's chemist over

16 years; toxicologist; coroner's physician over 4 years;
2660 still teaching toxicology at Rush Medical College. I am author of two books and a large number of articles published in medical journals. One book is "Toxicology" published in 1937; the other is "Medical Jurisprudence and Toxicology" printed in 1939.

2661 In a general way I am familiar with this case. Hydrogen sulphide is a gas having an offensive odor resembling that of rotten eggs. It has a formula of H2S, molecular weight 34. In high concentrations it is a very toxic gas. It can cause death in a few minutes in concentration of 0.15 of a per cent or over. In amounts less than that it may cause nausea, vomiting, giddiness; a person may drop to the floor unconscious, recover from such an exposure and not have any lasting effects. Smaller amounts have an irritating effect. It is an irritating gas. It is absorbed through the lungs and causes an edema of the lungs. It causes a conjunctivitis in small amounts; amounts from 50 parts up to 150 parts per million may cause this in some people, although not constantly. It is not a constant symptom. It has an effect upon the nervous system. It may cause, first, a rapid breathing and later on the breathing becomes short, snappy. The person may have tremors,, become extremely restless, all of which is described in the book as an agitation. It means restlessness. The gas
2662 is abosorbed into the blood and is changed ultimately to sulphates. It is not a cumulative poison like lead or some metallic fumes. It is destroyed rapidly within the system. It is a gas found in mines, sewers, and wherever there is decomposition of organic matter which contain sulphur, whether this sulphur is inor-

ganic or organic form. It is found around the distillation of oil, where mineral oil is being distilled for its various fractions, and in that sense has, in that place caused many cases of illness and even deaths. It is found in the artificial silk industry along with carbon disulphide. It is found in cesspools, gypmsum mining. It is found in septic tanks, Imhoff tanks, in quantities varying from nothing up to a tenth of a per cent. Concentration of hydrogen sulphide as low as 100 parts per million may cause local irritation and depression of the nervous system not unlike that following a prolonged course of bromides. Concentrations such as that are chiefly found in industry. If a man was in a large
2663 sewer where there was putrefactive matter, he could get concentrations, but it would be only in enclosed spaces where we find such concentrations. In my opinion, it would not be possible to obtain in the open air from a stream polluted with sewage wastes a concentration of as much as 100 parts per million of hydrogen sulphide.

At page 209 of my book entitled "Medical Jurisprudence and Toxicology", appears the following statements:

> "Hydrogen sulphide by its direct action on tissues induces the phenomena of local inflammation and, therefore, is classified as an irritant gas. Breathed in its pure state, the gas is immediately fatal. It acts upon all animals through all tissues, especially in lungs. If somewhat diluted, it produces nausea, giddiness, cold skin, labored breathing, irregular action of the heart, transient auricular fibrillation, as noted in one case (omitting the reference), pains in stomach and death by coma

or in violent convulsions with tetanus and even delirium. In greater dilution, sleepiness will be produced. The continued respiration of the gas proving fatal, sensibility not being restored. In exceedingly dilute conditions it sometimes occasions febral symptoms somewhat resembling typhoid. Fatal edema of the lungs can be produced experimentally in animals by exposing them for many hours to concentrations of hydrogen sulphide, 500 parts per million, insufficient to cause marked general symptoms."

The first three lines refer to concentrations of over one-tenth of one per cent—that would be concentrations greater than 500 parts per million, to produce those results upon human beings. If diluted it produces nausea. That can be produced in some individuals with as low a concentration as 50 parts per million, and the code now allows a maximum of only 20 parts per million for hydrogen sulphide. The code is what we follow along that line, so 50 parts per million in some people would cause nausea, giddiness, but the cold skin, labored breathing, irregular action of the heart is caused only by dilutions of 200 to 300 parts per million and that refers also to the pains in the stomach, and death by coma would only be in excess of 700 parts per million. Two to 300 parts per million will cause sleepiness in some people. I have inhaled 200 parts per million for several hours without getting any sleepiness, although I have felt nausea. The fatal edema refers to over 500 parts per million. The conjunctivitis can be caused in people from 50 parts per million and up and in some people even 100 parts per million will not cause conjunctivitis.

I am familiar with Brandon Road Pool; I have been
2666 there many times. I know where it is; I know the ex-
2667 tent of it and the locations. To get a concentration in the open air above the surface of the water in Brandon Pool of 100 parts per million of hydrogen sulphide you
2668 would have to be right over some of these floating particles. The fact that a person was standing or walking over a bridge, it would not, in my opinion, be possible to get a concentration of 100 parts per million of hydrogen sulphide above the Illinois Waterway on the Brandon Road Bridge. I have been on two or three bridges there in Lockport a number of times and never noted a concentration that would be anywhere near 150 parts per million.

2669 My answer to the question whether in my opinion the Illinois Waterway as a result of receiving untreated or partially treated sewage could constitute an actual menace to the inhabitants of the communities of Joliet and Lockport, or to the people working or sleeping on boats over such waterway from the presence of hydrogen sulphide, would have to be that the conditions would have to be comparable with the air conditions when I crossed that stream. If it was such, I would say there would be no menace to health. What they might be at some other time would be a conjecture on my part. It might be very high and it might be nauseating to some people. When I crossed it numerous times it was not a menace to health. I crossed
2670 it two weeks ago Sunday. That was a very hot after-
2671 noon. It was in the 90's. Assuming an analysis of the air alongside one of the bridges at Joliet and under a bridge at Lockport showed no traces of hydrogen

sulphide, the air in the vicinity of such locations—the effect of hydrogen sulphide—would not constitute an actual menace to the health of the people of the communities.

Assuming a concentration of 100 parts per million of hydrogen sulphide right at the surface of the Illinois Waterway the concentration of hydrogen sulphide, say, three blocks away would be much less. It would be foolish for me to say. It would depend upon the velocity of the wind, the temperature and all that.

2672 There would be great dilution a thousand feet away. You would have to be right over this gas or decaying matter in order to get a concentration around 150 parts per million, because that gas is very soluble in water, and water takes up about three and a half times its volume of hydrogen sulphide. If you were more than five feet away you wouldn't get that concentration. That concentration would be diluted many thousand

2673 times when you got 500 or a thousand feet away. Even under the most favorable atmospheric conditions for preventing diffusion, if you proceeded more than five feet away, say, to 100 feet away the concentration would have been reduced several thousand times. The gas is heavier than air. Its specific gravity is about 1.92 compared with the air, so it would hang low — it wouldn't go up suddenly in the air, but if it was a hot day some of this would go up high and these gases like

2674 hydrogen sulphide can be smelled for long distances away though the concentration at point of origin is small, say, 150 parts per million. In order to get these deleterious effects described in my book you would

have to have the concentrations I have testified, say, anything from 50 up—some people would feel the effects of the gas. It will be true of any gas, any solvent, that some people are much more sensitive to the smell of hydrogen sulphide and other smells than other people. We can have some people work with benzol for years
2675 and not have any effects, and other people work right alongside of them, the same concentration and within a year they are very sick.

Yes, there is something in the idea that you get accustomed to an odor. The Olfactory sense can be paralyzed so that after a while you don't notice the odor. If you are working with some very foul material like samples of fertilizer from tankage, the first time you work in a place like that it makes you sick to your stomach and after a while you could stir it up with a spoon and eat your dinner alongside of it and it will never bother you. Fertilizer plants and stock yard plants give off ammonium sulphide and hydrogen sulphide, indol and some mercaptans. That is in the tankage room and in the drying room.

2676 When people in the neighborhood of fertilizing plants and stock yard plants complain of odors they are complaining of hydrogen sulphide. There is not much complaint of stock yards odors here in Chicago. People living around there know that it is one of our industries and say nothing, but the odors still exist. The odor comes as far north as Foster Avenue some times. That is 5000 north. That varies with the wind. It is worse in summer than in winter.

2677 You can't detect it out here, but there is some hydrogen sulphide in the material. The people living

in the neighborhood probably complain or claim it is hydrogen sulphide, but it is a lot of other things than hydrogen sulphide. What they smell is not hydrogen sulphide, and the same is true of a fertilizer factory—
2678 they smell a lot of other material. The things that cause the offensive smell near a stock yards are what we call animal odors, tankage odors—they are sulphides, mercaptans usually. I was in a packing house for a long time and I never saw anybody sick from those odors emanating from it. Yes there are some recorded experiences of extended illness from odors in sewage plants. In some sewage there is a high concentration of hydrogen sulphide. You may have no hydrogen sulphide or it may run up to even 8 per cent. In my book I record 2.88 per cent coming from Paris sewage, but we have other figures where it may run up as high as 8 per cent. That is in enclosed spaces. There are no recorded cases of any epidemics of illness from hydrogen sulphide breathing from open water-
2679 ways like this waterway, but around petroleum distilling tanks hydrogen sulphide in the purification of mineral oil—death has occurred from hydrogen sulphide, numerous illnesses. This was within 25 feet of this distillation process. There is no recorded instance in the literature of toxicology of deleterious effects from hydrogen sulphide from a waterway. All of them are industrial plants.

Cross-Examination By Mr. Wallenstein

2680 I personally have not made an analysis of the air at Brandon Road Pool. On the occasion of the visits I spoke of, I crossed there several times during the summer of 1939.

Q. "Mr. Howson, one of the witnesses in this case, in Vol. IX, pages 1940 and 1941 of this transcript was asked the question—'Will you explain Mr. Howson, just what occurs or might be expected to occur in the Brandon Road Pool when hydrogen sulphide is formed and produces some of these odors complained of?' Mr. Howson answered: 'Well, the hydrogen sulphide that reaches the surface and is detected usually comes to the surface, I think, accompanied by—well, certainly accompanied by other gases, and frequently accompanied by disturbance in the sludge depending upon the origin, whether of liquid or sludge origin, of the hydrogen sulphide. It is part of the sludge of digestion, usually in waters of low sulphate content, such as Lake Michigan water, oh, possibly one per cent more or less of hydrogen sulphide in the sewer gas.'

2681 "To further assist you in the question I am about to ask you, let me read you from the testimony of Dr. Buswell in Volume IX, page 1896 of this transcript. Dr. Buswell was asked by Mr. Naujoks the following question: 'Doctor, what are the principal constituents of the gas that bubbles up through the water in Brandon Road Pool?' The Doctor answered: 'From analyses of gas from similar situations I would expect that it is largely methane, which is an

odorless and colorless gas, and an appreciable amount, perhaps 20 per cent, of carbon dioxide, ordinary carbonic acid, and probably 3 or 4 per cent of nitrogen. I would not expect to find more than 1 per cent of hydrogen sulphide, if that. I haven't made analyses of gas from that—'

"Now, Doctor, assuming that these statements are correct as to the approximate amount of hydrogen sulphide contained in the gas generated by the decomposition of sludge at Brandon Road Pool, have you an opinion as to what the effect would be upon a person who inhaled such a gas

2682 for a period of time. This one per cent was over the surface of the water so people could breathe it."

A. "That would kill any person that was breathing a concentration of one per cent, because 0.15 to 2 per cent is fatal within 15 minutes. That would kill them immediately."

Assuming that the approximate figure given by Mr. Howson and Dr. Buswell as to the amount of hydrogen sulphide contained in the gas generated at Brandon Road Pool is too high—that it is diffused with ten times as much air so that its concentration is reduced to 1000 parts per million, the effect upon a person who breathed this gas for a period of time would be very dangerous.

2683 A thousand parts per million would be very apt to kill over half the people that breathed it within one hour. Assuming that this gas described by Mr. Howson and Dr. Buswell as containing 1 per cent hydrogen sulphide became diffused with air so that its concentration is reduced 100 times, that is, so that there

are 100 parts of hydrogen sulphide per million, there would be no cumulative effect to that gas upon a person who inhaled this odorless gas for a period of 60 days over a four or five months period and for periods ranging from 2 to 7 hours. They would get only the effects of the day that they breathed that gas. That would cause an irritation of the lung and in many individuals it would cause nausea, and some sensitive individuals might have an irritation of the nervous system. It might produce headaches.

If I were to assume as correct the testimony of Beulah Booklund appearing on page 906 of the record, that the
2684 paint on the houses located along Railroad Street, which is about 750 feet from the canal, abutting Brandon Road Pool, was affected in the manner she testified, i. e., turned black, I would say, in the absence of trains, smelter smoke, foundry smoke, hydrogen sulphide would have this effect upon buildings painted white with lead paint. Hydrogen sulphide will cause the formation of lead sulphide in any paint containing lead, usually lead oxyacetate—white lead it is called.
2685 That canal has an oily residue and boats all have a thin black scum along the water line. Undoubtedly that mineral oil carries along some of the gases and it would discolor the paint. I have seen one or two boats and I have never noticed that their brass work was discolored black. If you had a brass fixture in this
2686 room any length of time it will turn color. That is why in fire departments they have to keep that brass polished every day to keep the right color. Silver would be turned black by hydrogen sulphide. A concentration

even as small as .0025 would cause discoloration of paint—lead paint.

I have read the article by Mr. Yant in "The Hydrogen Sulphide Industry" and agree with his table show-
2687 ing the physiological response to hydrogen sulphide,

(This was thereupon received into evidence as McNally Cross Examination Exhibit 1, and is as follows:

2688 "PHYSIOLOGICAL RESPONSE TO HYDROGEN SULPHIDE.

"Physiological Response—The physiological response attending exposure to various concentrations by volume in air is as follows:

"0.005 to 0.010 per cent: Subacute poisoning—slight symptoms such as mild conjunctivitis and respiratory tract irritation after 1 hour exposure.

"0.02 to 0.03 per cent: Subacute poisoning—Marked conjunctivitis and respiratory tract irritation after 1 hour exposure.

"0.05 to 0.07 per cent: Subacute poisoning—dangerous in ½ to 1 hour.

"0.07 to 0.10 per cent: Possibly acute poisoning—rapid unconsciousness, cessation of respiration and death.

"0.10 to 0.20 per cent: Acute poisoning—rapid unconsciousness, cessation of respiration, and death in a few minutes.

(Page 603, American Journal of Public Health—Excerpt from article "Hydrogen Sulphide in Industry Occurrence, Effects, and Treatment" by W. P. Yant.)

2689 I also agree with Table I in Mr. Yant's article, except the last figure of 27 parts per million opposite the

item, "Strong, cogent, forceful, not intolerable." Alice Hamilton and Drinker of Boston now believe 20 parts per million are intolerable, and the code says 20 is the maximum that should be tolerated by workmen in industry.

(Said Table I was thereupon offered and received in evidence as McNally Cross-Examination Exhibit No. 2, and is as follows:)

2690 "ODOR INTENSITIES FOR VARIOUS CONCENTRATIONS OF H2S

	Concentrations of H2S in air	
Intensity of Odor	Parts per million	Percent by volume
No odor	0.022	0.0000022
Detectable; minimum perceptible odor	0.13	0.000013
Faint; a weak odor, readily perceptible	0.77	0.000077
Easily noticeable; moderate intensity	4.6	0.00046
Strong, cogent, forceful not intolerable	27.0	0.0027"

(Table I, page 605, American Journal of Public Health--Excerpt from Article "Hydrogen Sulphide in Industry Occurrence, Effects and Treatment" by W. P. Yant)

2691 A number of investigators in the field of toxicology, industrial toxicology got together and from experimental data they made up this code for Massachusetts that I spoke of—just published in the Journal of Industrial Hygiene and Toxicology for June of this year—which will probably be used all over the United

States. Alice Hamilton, who was head of that department in Washington and well-known industrial toxicologist and Drinker, of Harvard University, are the co-authors of that table. They have come to the conclusion that not more than 20 parts per million of hydrogen sulphide should be tolerated in any industry because above that it was harmful.

2692 I estimated that as low a quantity as 25 parts per million would be required to turn paint black at 750 feet. The amount of hydrogen sulphide in the air required to change the paint would be much less than 20 parts per million—much less than the concentration to cause illness. The fact that it would turn the paint would not indicate that it would cause illness.

(At this point an extended colloquy took place between Master, the witness and counsel as to the method of converting percent into parts per million. At the suggestion of the Master a recess was taken while the witness explained the formula to counsel. After recess the witness resumed the stand and testified as follows)

2697 You are correct in understanding from my previous testimnoy I said that at 750 feet from the canal in order to blacken these houses I gave an approximate figure of a concentration of .0025 hydrogen sulphide, and that would be 25 parts per million.

2698 The maximum for safety in the Boston code of which I spoke was .0020 or 20 parts per million. The statement at page 208 in my book Medical Jurisprudence in Toxicology "it has also been found that a concentration of as little as .005 to .01 per cent will cause a

conjunctivitis, popularly known as gas eyes" means the lowest figure of .005 is 50 parts per million. That would be twice as much as the figure given with reference to blackening the paint. One per cent would equal 10,000 parts per million.

Redirect Examination By Mr. Naujoks

2699 Yes, automobiles give off a poisonous gas. The combustion of gasoline is incomplete, and the average 6.7 per cent of carbon monoxide, CO, which is very highly toxic gas. A one per cent concentration of carbon monoxide would kill within two or three minutes. Concentrations of carbon monoxide and hydrogen sulphide causing symptoms parallel. They are very toxic gases.

2700 Based on the number of times I have crossed the Illinois Waterway comprising the Sanitary District Canal, been in Joliet, been in Lockport, it is my opinion such waterway was not a menace to health on those days I passed through this place.

The Massachusetts Code is predicated on the fact that the air in thees industrial plants is charged at all times with that concentration of hydrogen sulphide.

Recross Examination By Mr. Wallenstein

2701 A concentration of hydrogen sulphide in the air expressed as .0027, meaning per cent by volume would be close to 27 parts per million. The odor given off by such a concentration would be noticed by nearly everybody unless they had a defective sense of smell.

Redirect Examination By Mr. Naujoks

2702 If trains went by and gave off hydrogen sulphide in the smoke—and they do give off hydrogen sulphide and sulphur dioxide—that would be sufficient to cause a discoloration of paint on houses for some distance away.

October 16, 1924

Direct Examination By Mr. Naujoks

3100 DR. M. STARR NICHOLS. I am a chemist, bacteriologist, teacher. Graduated in pharmacy from Highland Park College in Des Moines in 1905; registered pharmacist, State of Wisconsin 1913; Bachelor of Science, University of Wisconsin 1916; Master of Science 1918; Doctor of Philosophy, Physiological Chemistry, 1926. My experience has been quite varied, principally in the field of water and sewage sanitation; some experience
3101 teaching clinical laboratory diagnosis to medical students; teach water and sewage chemistry to engineering students. I teach at the University of Wisconsin, but teaching requires approximately only 30 per cent of my time. The rest of the time is in the State Laboratory of Hygiene, in which laboratory are done the analyses for the State Sanitary Engineering Department of the State Board of Health. I am an employee of the State of Wisconsin.

I am a member of Sigma Psi; member of American Chemical Society; Fellow of American Institute of Chemists; Fellow of American Medical Association; member of Federated Sewage Works Association; mem-

3102 ber of the Society for Experimental Biology and Medicine; member American Water Works Association.

I am to some extent familiar with the Illinois Waterway and Brandon Road Pool. I have made two trips to Brandon Road Pool.

I failed to mention that I hold the rank of professor
3103 of sanitary chemistry at the University of Wisconsin; that I have published some 30 to 40 papers on subjects relating to water and sewage; that recently I have written three chapters in the book known as "Water Supplies", written by Turneaure and Russell. The three chapters had to do with the quality of water and its examination.

The results of my tests and analyses of the water, air and scum at Brandon Road Pool are shown in this report which is hereby offered in evidence and marked "Opponent's Exhibit No. 15".

3112 The first part of this report has to do with an attempt to arrive at the bacterial pollution of the air at the locks and at nearby points. The test was made by exposing sterile nutrient agar and malt agar plates at various locations. By this method it was hoped that bacteria present in the air would lodge on the agar plates and establish what is known as a colony when they grew. By counting the number of colonies which grew on these plates we hoped to arrive at comparative concentrations of bacteria in the air at these various points. Those results are shown on the first table on page 2.

You will note that only plates 2, 3, 6, 12 and 13 are listed. The missing numbers are not shown because they dried up while they were open to the air. In

other words, the culture material, the water from the culture material, evaporated. We had hoped to get results at many other points not shown. However, the ones shown in this table are considered satisfactory, and the results you can see in this report.

3113 Because of the fact that all these testing points did not produce satisfactory results, it was decided to make another atempt with what we consider a more accurate method for determining the number of bacteria in the air. It is realized that these counts probably do not represent the total number of bacteria present in the air but the results will be comparative one with the other. The principle of this method is that of impingment. When you direct a column of air it tends to go in that direction until something changes it so our idea was to draw this air in directly on top of an agar plate through an orifice. This movement of air was produced by a pump calibrated to deliver so many cubic feet in

3114 a certain length of time. In this particular instance we standardized on one cubic foot of air per minute. As the air impinges on this agar plate, the bacteria are caught on the moist surface, and after being incubated, produce the colony of microscopic size which can be counted readily by use of suitable apparatus similar to the "Quebec" colony counter in these experiments.

The results shown in the next table should represent the character of the air as to its bacterial content by means of comparison, at least, one plate with another. You will observe from the table that the number of bacteria at various locations varies considerably, and that in the city proper of Joliet, Illinois there does not seem to be any remarkable difference from the numbers

found at other cities in Illinois and in the rural areas. There is one outstanding difference which I believe should be pointed out, and that is that the number of bacteria at Brandon Locks, that is Station C; Brandon Dam, Station D; Lockport Locks, Station H, all three
3115 show approximately one-tenth as many bacteria as are found at the other stations.

The types of bacteria present gave no information I can see, except to say that they are varied and there are many varieties present. No attempt was made to isolate any pathogenic organisms, nor was any attempt made to identify the species of bacteria growing.

On page 7 are shown six of these plates. Aside from the plates obtained at the three points on the locks, all the rest of the plates were more or less similar, and so I tried to pick locations which would give a picture, at least, of the condition at the locks, in cities, and in the country, and you will note from the picture of the plates that there are fewer colonies on the lock samples than are present on the other plates.

The chemical part of this work consisted in determining hydrogen sulphide in the canal water at three separate points—one at a point one block north of Jefferson Street Bridge; one at the canal just above Brandon Lock upper gate, and one at Lockport locks in the canal above the upper gate. The first two of these
3116 showed two-tenths of a part per million hydrogen sulphide. The latter—the one at Lockport Locks—showed one-tenth part per million.

Samples of scum were also analyzed, and a description of the scum and analysis is to be found on page 3. On one sample of scrapings was extracted oily tar-like

material, not identified as to its source. The scrapings are removed from the canal wall and contain, as found 21.8 per cent of oily tar-like material which we calculated on a dry basis would amount to 42.3 per cent. Note also these scums 2 and 3 reported are from selected points inasmuch as the scum was not found at all places in the canal, locks and Brandon Pool.

I would like to call your attention to the analysis under paragraph 4 of this page 3, in which a determination was made on the effluent flowing away from the Texas Company plant, Lockport, Illinois. This sample showed a similar oily tar-like substance amounting to 58.7 parts per million, which on the basis of a quantity of water which has been reported to be used by that company would amount to some 12,000 pounds of oily tar-like material daily. Note that this effluent does not
3117 contain hydrogen sulphide and that its Ph is practically normal.

The Master

Ph has to do with the intensity of the acidity or alkalinity. In this case it would mean that the water was practically neutral as far as the acidity or alkalinity intensity was concerned. In making the test for hydrogen sulphide a sample of 100 cubic centimeters of water without aeration was placed in a hundred cubic centimeter cylinder, glass cylinder. To this was added 10 per cent of its volume or 10 cubic centimeters of concentrated hydrochloric acid. To this was added from
3118 10 to 20 milligrams of para dimethylamino aniline sulphate, and the cylinder and contents inverted gently.

To this was added one cubic centimeter of one per cent ferric chloride solution. The resulting mixture, if hydrogen sulphide is present, becomes some shade of blue, depending upon the concentration of hydrogen sulphide. I did not make any test for hydrogen sulphide in the air as distinguished from hydrogen sulphide in the water. I wasn't asked to do that. In selecting a sample of water from the effluent of the Texaco Company we made what was known as a "grab" sample, that is, taken at one particular time in the middle of the stream which was flowing away from this plant, the idea being to select as near as possible a representative sample of that effluent. No attempt was made to get the scum because I got scum from that same place by taking the sample near the banks of the stream, but my idea there was to find out what was really in the water flowing away from the Texas Com-
3119 pany plant. At other points the samples were taken actually to get the scum, and do not represent the character of the water in general in the pool. I failed to see any points where bubbles were arising. Bubbles may indicate the presence of some gas but not necessarily hydrogen sulphide.

Mr. Naujoks

The hydrogen sulphide samples were selected because of the proximity to suggested complaints. In other words that was quite close to St. Joseph's Hospital, the one near Jefferson Street Bridge, and the one taken down at Brandon Locks was just to find out if there was any difference in it.

The Master

3120 I didn't know about there being bubbles coming up any place at that time and if I had known that I certainly would have liked to have found the concentration at those points. They may have thrown some light on whether or not those bubbles are hydrogen sulphide. I didn't see any bubbles on my visit which was on September 27th and 28th when I was down there the last time. That is the time I made the hydrogen sulphide examination.

Mr. Naujoks

3121 I think the amount of hydrogen sulphide at various places might vary, although I have no information upon which to answer in the affirmative or in the negative on that question. I noticed an odor along the Illinois Waterway at the time I visited the Brandon Road Pool. I would like to offer my opinion that it was an oily tar-like odor, and I was anxious to find out whether I could smell any hydrogen sulphide, and I was observant particularly for that compound because of its apparent significance here, and I felt that I ought to be in a position to determine whether it was present or not because I worked with it in the chemistry laboratory.

The Master

The odor one gets on going into a badly kept urinal in a railroad station or in a small town is not that of hydrogen sulphide.

3122 That is ammonia practically and certain aromatic substances from urine which are not related at all to hydrogen sulphide.

3123 Rotten eggs would be the best single substance to describe hydrogen sulphide, although you get other odors there if the egg is very bad. On my visits (to the Pool) I got no odors of either stale urine or rotten eggs. When we crossed the Brandon Road Bridge going out in the country to collect a sample of bacteria, we noticed a slightly different odor which I am freely willing to admit had a sewage odor to it. It is hard to describe an odor. It is the odor you get around sewage plants. The interesting thing in regard to odors at Joliet was, as I noticed it, at Brandon Locks the odor
3124 was mild. As you neared Lockport, you began to get an extremely strong tar-like odor. On the first visit Mr. Warrick and I walked up the locks to the Texaco plant outlet of their waste and the tarry odor got stronger as we went towards that plant. In taking samples of the scum at Brandon Locks I held Mr. Warrick's leg and he reached down and got the scum. I couldn't
3125 answer the question, "What is the material in that scum, generally?" because I haven't analyzed it. It is a very difficult material to analyze. My examination for bacteria didn't include the scum. It would be my opinion that bacteria couldn't live in that scum.

The examination for hydrogen sulphide was made on specimens of water without scum. The tar-like sub-
3126 stance was extracted from the scum in two instances; form the scrapings from the lock walls in one instance and from what I considered to be the representative sample of the Texaco effluent collected in the middle of the stream.

3128 The average amount of B coli found in raw sewage is from two million up to possibly 25 million per cubic centimeter. Three or four experiments I know of have shown that typhoid germs were destroyed more quickly in polluted water than in pure water. Typhus and typhoid are two different diseases entirely. Typhus is mostly caused by rickettsia bodies. There is some typhus in the Eastern States and I think occasionally they
3129 get typhus at the West Coast. A very small number of
3131 cases, comparatively speaking. It is very difficult to answer the question, "If all the hydrogen sulphide present in the water in the Brandon Road Pool were capable of being released instantaneously, would this produce a sufficient quantity of hydrogen sulphide in the air above Joliet to produce a toxic effect?" I cannot answer it yes or no, but it is my opinion there would not be sufficient concentration in the air if all of the hydrogen sulphide of two-tenths parts per million were released instantaneously, if you would consider a volume of air surrounding the buildings of Joliet. It must be understood that a concentration could be attained by an instantaneous release at points directly above the water, which would be toxic in the opinion of experts, that is, above 10 parts per million, and I doubt very seriously if you could take a sample at St. Joseph's Hospital after that release had been effected,
3132 that you would find as much as one-tenth part per million in the air. It would be my opinion that no matter how great the concentration was at the point of release above the surface of the water, by the time

it got to St. Joseph's Hospital the dilution and diffusion would be so great that it could have no effect. If the quantity of hydrogen sulphide in the pool were the same in June and July as for September and October
3133 I would make the same statement. I am limiting my answer to what I found at that date. A concentration of two-tenths of one part per million of hydrogen sulphide in the water was not noticed by myself on a bridge crossing. I would need to know the concentration in the air before I would be able to give an idea about what concentration you would be able to notice if it were present and you were looking for it. The testimony this morning brought out that different people have different sensitivities as far as odors are concerned and one person might be able to detect .13 parts per million and another would require a larger amount. The man who has done most of the work on that maintains that to detect as low a quantity as that they must come from fresh air and make their observation practically
3134 instantaneously or else they get fatigue and won't even notice that amount. In accordance with physical chemical laws hydrogen sulphide in water would not, as far as I know, be capable of being released instantaneously.
3135 It would diffuse out slowly and the lower the concentration the lower the rate of diffusion. Aeration removes hydrogen sulphide rather rapidly, and is used in water works practice to remove this obnoxious component of some underground waters. At times I, as a chemist, work in an atmosphere containing hydrogen sulphide. I often breathe hydrogen sulphide in my work, but not any more often than I have to. Ordinarily, chemical laboratories nowdays are provided with

exhaust hoods to remove this compound but the apparatus isn't very efficient. I have visited the Qualitative Chemical Laboratory in which there are probably 200 or 300 students, and you can get plenty of hydrogen sulphide odor when they are working there. An additional diversion up to 3500 cubic second feet would decrease the concenrtation of B. coli in the water passing through Joliet but, of course, the total number that
3136 went by Joliet would be just the same. By concentration I mean the numbers per unit volume. The fact is I think there is a possibility that there might be more numbers if there is any difference, because of the killing off effect of strong, stagnant water, polluted water, except in certain kinds of organisms like the aerogenes type of colon. That organism might multiply better in the stronger waste, but the type that is found in the intestinal tract and is present in many million per c.c. of feces, is not supposed to multiply in nature and would, as far as all experimental work that I am acquainted with is concerned, die off somewhat in polluted water. That is known as aero-bacteria. There are about 32 to 35 varieties of this colon organism. Some 7 or 8 varieties are found in the human feces. Others have their habitat in organic matter that is undergoing decomposition.

3137 At one location—Brandon Locks—we found an ant on one of the plates. None of the plates shown on page 7 of my exhibit indicate that any insects walked on
3138 them. The fact of the matter is the apparatus was screened so that no insect could get in with the in-rush of air. It had a screen over it to keep out anything that might possibly be there aside from the air and the dust particles. I didn't determine the species. I made no determination for pathogenic organisms.

3139 The organism listed on page 6 of my exhibit indicated as similar to escherichia coli is the one defined in the feces, but note that I have not said that the organisms found were escherichia coli. This organism is typical of sewage pollution, but there are many organisms that are not escherichia coli that are similar to es-
3140 cherichia coli. You find them everywhere. I might just as well have said that the organisms under No. 6 classification could have been said to be B. proteus which have nothing to do with sewage. You couldn't tell escherichia coli and B. proteus apart under the microscope. The reason I put escherichia coli in there is simply beacuse it was the first thing that came to my mind of a short gram negative rod, and it doesn't mean
3141 anything in connection with escherichia coli. The key is simply a method of saying what morphological types are present and that is all the report states—that they are morphological types. There are nineteen different kinds of morphological types listed and No. 6 is a type similar to escherichia or similar to B. proteus. I could

have said similar to typhoid if I wanted to and be correct. Morphology has to do with nothing except the form. Morphological types mean simply the shape and staining characteristics of the organism when stained with a certain type of stain, and that is all they mean.

3143 I made no determination of species so I wouldn't know whether there was any sewage types or not. My sole purpose in making this bacteriological aid analysis was to determine the relative numbers of bacteria at the locks and at distant places from the locks, and I simply put down the morphological types to indicate what I saw under the microscope without further identification of species. I found no hydrogen sulphide in the Texas Company wastes. These tests for hydrogen

3144 sulphide were made on September 28th (1940). The temperature of the water on that date was not measured. The temperature of the air at Joliet, Illinois at 11:25 Central Daylight Savings Time was 70 degrees Fahrenheit at the Lock House. The water would be cooler now than it would be during the summer. I observed no bubbling. I have no way of knowing what the activity or decomposition of the organic material was as I made no tests. Chemical and biological reactions increase with increase in temperature.

3145 This chart headed "Gases from Sewage Sludge Digestion" and from in "Industrial Engineering Chemistry" simply tells that hydrogen sulphide is produced in larger volume as the temperature of digestion rises. The chart shows that at a temperature of 66 degrees where you might have .2, if the temperature were 76 degrees you might have .9 per cent by volume hydro-

3146 gen sulphide in sewage sludge digestion. It should be inserted that this chart refers to the rate in volume of gas production from sludge digestion in Imhoff tanks and not in the waterway. The conditions are entirely different in this experiment and in what would happen in a natural waterway, but there is no doubt but what there would be increased hydrogen sulphide production with increased temperature. I don't know that it would be anything like as great as that. May I inject here that all the chemical reactions taking place in the waterway are increased by increase in temperature. If hydrogen sulphide is produced at a greater rate by a higher temperature, so will that hydrogen suphide be eaten—oxidized if /oxygen is present in the air or in the waste—by a higher temperature. If you have oxygen present, your hydrogen sulphide disappears that much quicker. Of course, now there is no oxygen present there, so it may not disappear, except for the
3147 fact the solubility of hydrogen sulphide is less at a higher temperature than it is at a lower temperature. The production of hydrogen sulphide in an Imhoff tank probably takes place from two sources: One from the protein material, the other from the sulphates contained in the carriage water. No two Imhoff tanks will produce the same quantity of hydrogen sulphide, due to variations in these two components. Likewise no direct comparison from these results can be made with another plant, and probably much less to an open stream in which we have entirely different conditions.

The Master

3148 It is true that increased temperatures tend to generate more hydrogen sulphide. With similar quantities of sulphur proteins and sulphates, if you conduct that digestion at a low temperature you will get less hydrogen sulphide than you will at the higher temperature. That goes for Imhoff tanks. I think it is essentially true that if you had the same quantity of untreated sewage in this open waterway at Joliet in September as you had in July and your temperatures were much higher in July than in September, you would expect to find more hydrogen sulphide in July than you would in
3149 September, but it would not follow that the rate of increase in hydrogen sulphide in an open waterway from a cool day to a warm day would be the same as the rate of increase in an Imhoff tank from a cool day to a warm day.

Mr. Clausen

I know Mr. Hatfield. He is Chairman of the Standard Methods Committee of the Federation of Sewage Works Associations.

The Master

Assuming that there is a certain degree of concentration of hydrogen sulphide gas at a certain point on the waterway, the diffusion from water to air would be faster in hot weather than it would in cool weather because the solubility of hydrogen sulphide is greater at a lower temperature than it is at a higher temperature.

3150 In the hot weather the hydrogen sulphide would get from the water into the air more rapidly than in cool weather. Assuming the hydrogen sulphide has gotten out of the water into the air, the diffusion in the air would have very little to do with the temperatures of the air, because both gases expand with heat at the same rate approximately. The only thing which would tend to make hydrogen sulphide diffuse more rapidly would be air currents.

Mr. Clausen

Hydrogen sulphide is slightly heavier than air. Moisture in the gaseous form would have nothing to do
3151 with the diffusion of hydrogen sulphide. Barometric pressure would have the same effect on the air as it had on the hydrogen sulphide, and I doubt that diffusion would be any different. I think the diffusion would be approximately the same provided the moist air was in gaseous form. I know that only from my knowledge of physical chemistry and general chemistry, inorganic, and a few things like that.

Broadly speaking, a pathogenic organism is one capable of causing disease in man or animals.

If I had undertaken to make an examination for
3152 pathogenic organisms, the next step in the procedure would be the isolation of these individual colonies. In other words, we would transplant from those colonies the organisms growing into suitable media, and when we had other biological characteristics in different kinds of culture media besides agar, we might resort to animal experimentation to prove it. Agar is a sea-weed. It is produced on the West Coast of California some-

what now. It is a sort of substance which is dry and when you mix it with water it swells up, and when you get it up to the boiling point it dissolves apparently, and then stays melted until the temperature drops to about body temperature, at which point and a little above it becomes solid.

Redirect Examination By Mr. Cohan

3154 It does not necessarily follow that these bubbles observed on the surface of Brandon Pool are hydrogen sulphide gas bubbles. There is very apt to be a gas known as methane in those bubbles rather than hydrogen sulphide, because methane is much less soluble in water than hydrogen sulphide.

The Master

3155 Methane gives off no odor. Methane, in sludge digestion is one of the principal gases evolved and in much larger volume always than hydrogen sulphide. You can have hydrogen sulphide without bubbles. Bubbles would be indicative of great activity of gaseous nature. The bubbles could possibly be hydrogen sulphide, but because of the solubility of hydrogen sulphide at 30 degrees Centigrade, which would be rather warm temperature—32 degrees is about 80 I believe—hydrogen sulphide is soluble about 2 c.c.'s of the gas in 1 c.c. of water. In other words if it traveled from the point of formation in the sludge at the bottom towards the top, I doubt very much whether a large bubble would ever get there because it would be dissolved before it got to the top, provided there was less than 2 or 3 parts

3156 per million of hydrogen sulphide in the water. If it had an odor it couldn't be methane. As to this solubility I was describing, it makes very little difference whether air or hydrogen sulphide is over the water until the bubble gets to the air-water surface.

Recross-Examination By Mr. Wallenstein

3157 The amount of hydrogen sulphide given off from the water depends on whether there is air or hydrogen sulphide above the water. When you talk about the solubility of a gas in the water you take the condition in which you have one atmospheric pressure ordinarily above the water in which you are making your solubility test. You assume that to be fifteen pounds' pres-
3158 sure, the same as ordinary atmospheric pressure at sea level. That is the pressure of just ordinary air. If you were going to mix one part of hydrogen sulphide and a million parts of air it would affect the result. Much less hydrogen sulphide would dissolve in the water, but if your going to talk about solubilities of a chemical substance you ordinarily expect to have the pure substance in solvent—in this case water.

October 17, 1940

DR. M. STARR NICHOLS (Recalled)

Cross-Examination By Mr. Clausen

3208 As far as I have gone in my investigation it is very unlikely that we might have the following pathogenic organisms: B. Anthracis, B. diptheriae, pyogenes albus, B. Typhosus, B. dysenteriae, septic sore throat, scarlet

fever, bargens bacillus of ulcerative colitis. It is very unlikely that they might have been on those plates — a remote possibility.

3209 The record should show that of bacterial types found in the air 99.9 per cent of them are not pathogenic organisms. There is one chance in a thousand that type No. 1 shown on page 2 of Opponents Exhibit 15 where I say "similar to B. subtilis" could also be B. anthracis. Under type 3 where I said "diptheroids" they somewhat resemble B. diptheriae. The chance that they could be present too is a very small chance, probably one chance in 10,000, 20,000, 100,000.

3210 Under 6 where I say similar to escherichis coli it could also be B. typhosus and B. dysenteriae and B. proteus and a thousand other organisms. Under 8 where I say streptococci, there is one chance in 100,000 possibly that it could also be septic sore throat and scarlet fever. Under 15 where I say streptobacillus there is one chance in a million that it might also be bargens bacillus of ulcerative colitis. Under 17 I doubt that it might be a B. typhosus. The rods, as I remember them, were so long they couldn't have been that. I wouldn't know whether they were or were not present. No attempt was was made to identify species. Air-borne infections of the type mentioned are very uncommon.

Redirect Examination By Mr. Naujoks

3211 My tests showed one-tenth of one part per million of hydrogen sulphide in the Sanitary Drainage Canal above Lockport and two-tenths of one part per million of hydrogen sulphide in the water of Brandon Road

Pool. My tests further showed 62.8 parts per million of sulphates in the effluent of the Texas Company which goes into the Brandon Road Pool. It would be possible for the increased amount of hydrogen sulphide present in Brandon Road Pool to be derived from the reduction of these sulphates in the Texas Company effluent.

Recross-Examination By Mr. Clausen

I saw a record that gave the average flow at the Texas Company as 23 second feet. That would be about 16 milloin gallons a day. My analysis showed no hydrogen sulphide in the effluent.

September 25, 1940

Direct Examination By Mr. Cohan

2465 DR. JAMES ELIAB PERKINS. I reside at 1 Salisbury Road, Elsmere, New York, near Albany. I am Director of Division of Communicable Diseases, New York State Department of Health. I received my Bachelor of Science and Doctor of Medicine from the University of Minnesota in 1927 and 1930, respectively; my Master of Public Health and Doctor of Public Health from the John Hopkins School of Hygiene and Public Health in 1931 and 1933, respectively. Following my internship at the Anker Hospital in St. Paul, '29 and '30, I was epidemiologist in the New York State Health Department the year of 1934. Then I was District State Health Officer of the New York State Health Department from January 1, 1935 until November 1938. I

have been Director of the Division of Communicable
2466 Diseases since that time. I am also Director of the Extension Course for physicians qualifying to become Grade 2 health officers in the State of New York, that is, since 1937; and since the same time in charge of the Public Health of Preventive Medicine in the Albany Medical College.

I am familiar in a general way with the order of the Supreme Court appointing the Special Master to make summary inquiry relative to the actual condition of the Illinois Waterway and whether that condition constitutes a menace to the health of the inhabitants along the waterway. I am familiar in a general way with the Waterway and this so-called Brandon Road Pool from my visit to it yesterday (September 24, 1940). We went down in an automobile, crossing the Waterway at several points; the first at U.S. 45, then at Lemont, then at Lockport and several places in Joliet, and also went to the foot of the Brandon Pool at the Brandon Lock.

2467 At the first two points, that is U.S. 45 and at Lemont, there was a slight odor perceptible that I would liken to the odor I notice from the effluent of a sewage treatment plant to which I take my Albany Medical College students. It was very slight but detectable. At Lockport the odor, apparently, was marked by the smell of oil from a little stream that runs just east of the Waterway, so I noticed hardly any odor from the Canal itself because of the smell of oil from this small stream. Down in Joliet the odor was again very slight. It too, was marked by the odor from a burning rubbish pile located apparently just north of Joliet on the western

bank. At the southern end of the Brandon Pool there was again just a slight odor similar to that I noticed up at the crossing of U.S. 45 and at Lemont. I was on top of the lock structure yesterday, and there was rather a strong breeze. Apparently it was coming straight down Brandon Pool.

2468 I did not observe any scum on the surface of the Waterway at any place.

Assuming that this Waterway is polluted because of the introduction of untreated or partially treated sewage, I believe only the enteric communicable diseases, most important of which are typhoid and bacillary dysentery, would emanate from the Waterway. Assuming that a polluted and septic condition exists and has existed in this waterway for some time and that it were diluted by an additional 3500 c.f.s. of Lake Michigan water I do not think there would be a possibility that the typhoid germs present in the water would decrease. In fact I think there would be a possibility you might even have an increase. You have septic conditions only when the pollution is so severe that the oxygen has been used up. You then have an anaerobic condition. The typhoid bacillus, like most non-spore-forming pathogenic organisms, is a very delicate organism. It is not anaerobic and would not live very long under anaerobic conditions, that is, in a septic stream of that

2469 sort. So, if you have further dilution you might actually have more viable organisms than typhoid bacilli present, and I would also think that with the increased flow you would have great possibility of transmitting these organisms over a greater area along the Waterway than otherwise. Individuals could contact these

diseases from the water in the canal only by swallowing it. That would, of course, occur principally through actual pollution of a water supply. I presume it is conceivable that a person swimming in it and inadvertently swallowing the water in that process would also possibly contact one of these enteric infectious diseases. Assuming that the water supply of the communities along the Waterway is safe from pollution from the canal, I do not consider that this present polluted condition of the waterway constitutes an existing, real and present menace to the health of the inhabitants of Joliet or Lockport.

Typhoid bacillus in the water is very sensitive to chlorine. With an adequate concentration of chlorine it will kill the typhoid bacillus. I am not a sanitary en-
2470 gineer but I believe in drinking water the usual accepted concentration effective for disinfecting the water at the point of discharge into the mains is one-tenth part per million. I also believe that the commonly accepted standard for disinfecting effluent from sewage that has undergone primary settling is five-tenths parts per million for a period of 15 minutes. So that if you had residuals, to that extent they are greater and your typhoid bacilli would be destroyed.

I do not think flies might be of importance in the transmission of typhoid germs from the canal. The house fly is the only insect that has been strongly incriminated in the transmission of typhoid fever. This was best worked out and brought most forcibly to the attention of public health workers at the time of the Spanish-American War, when there were terrific epidemics of typhoid fever in the various army encamp-

ments. Under those circumstances there were open privies, open pits, filled with fresh excreta from the men, and hordes of flies were going from the excreta to the mess kitchens and mess halls, and back and
2471 forth. That situation is quite different from this. Flies will not light upon the water and I doubt that there are very many typhoid bacilli. I do not agree with the testimony of Dr. Louis J. Frederick, Health Commissioner of the City of Joliet, appearing at page 458 of the record in which he said: "This material dries, the sun dries it. I am talking about the scum now, not the water, the scum on the water. They light on it and the sun dries it, and they light on it and it is carried, wafted away by the winds, where no one knows how far they carry it, but it has been known to be carried for miles." The typhi bacillus, as I have said, is a relatively delicate organism. It is readily destroyed by sunlight and by drying, and under the circumstances given there I believe you would not have any live typhi bacilli.
2471 I do not agree with Dr. Frederick's statement appearing at page 451 of the record where he said:

> "The scum that forms in the canal is loaded with bacilli that we call colon bacilli, the odor of which you will probably never appreciate unless you smell it and if you smell it once you will never forget it. It is one of the most deadly odors of any of the germs that we have in the human body, the colon bacilli".

The colon bacilli, per se, do not have any odor. As a mater of fact when I used to run water samples for the Minnesota Health Department I used to deliberately

sniff my endosagar plates of pure cultures of colon bacilli because I liked the odor which reminded me very much of freshly-baked bread. Mosquitoes do not transmit typhoid fever.

Cross-Examination By Mr. Wallenstein

The trip I spoke of yesterday was my first visit to
2473 the Brandon Road Pool. I performed no laboratory experiments with reference to the gaseous odor given off; just smelling. I observed no gas bubbles on the surface of the pool. In speaking of communica le diseases I think particularly of the diseases wh. .h are reportable to me in the New York State Health Department. There are some 35 reportable diseases in New York.

2474 I don't know whether I can give all 35. I can start off. Diptheria, scarlet fever, anthrax, glanders, bacil-
2475 lary dysentery, amebic dysentery, undulant fever, trichinosis, Rocky Mountain and spotted fever, typhus fever, paratyphoid fever. The communicable disease classification of Illinois are quite similar one state to the other. I do not consider hydrogen sulphide poisoning a communicable disease. I am not a toxicologist. I have had little direct experience with hydrogen sulphide poisoning.

2476 I do not believe that a polluted stream would give off sufficient hydrogen sulphide to be a public health menace.

2479 If sufficient hydrogen sulphide would generate from that stream so as to affect the large percentage

of the population of that community through toxic effects from that gas itself, then I would consider it to be a public health menace. I am not a toxicologist.
2480 I think that one has to distinguish clearly with regard to hydrogen sulphide between an odor from hydrogen sulphide but in insufficient concentrations to cause toxic symptoms, and sufficient concentrations of hydrogen sulphide to actually cause toxic symptoms from the hydrogen sulphide itself. I do know that you can have enough hydrogen sulphide to give a very distinct odor and yet have it be far below that necessary to cause toxic symptoms. I do not know what that percentage is.

2481 I can only say that it is beyond my comprehension, without being able to back it up with scientific data, that sufficient hydrogen sulphide would be generated to cause ill effects from the hydrogen sulphide itself, that is, the toxic effects. I was quite familiar with a situation not unlike this, a creek that was very severely polluted which runs through Gloversville and in through Johnstown and finally empties in the Mohawk River. Gloversville treats only a fraction of its sewage. Furthermore there are many tannery wastes. Johnstown empties all its sewage into that same little creek, with the result that every summer we had septic conditions, due to the bubbling from this gas, and I had many complaints as District Health Officer because of
2482 the nuisance created by that stream, but at no time during the four years I was District Health Officer in Amsterdam was any illness attributable to the hydrogen sulphide given off from that stream.

I have no idea as to the percentages of hydrogen sulphide given off by a stream required to create nausea in the ordinary person. I have no idea as to the parts per million. I believe, as has been brought out in the medical testimony prior to this time, nausea is a subjective symptom. Furthermore individuals can become nauseated, and so on, through the psychological effect of an odor. It would not mean that it was due to an actual toxic effect from the concentration of gas. I think it is necessary to keep these two things separate.

2483 It is difficult to answer whether, if a nausea condition results from the odorous gas, I would consider the source from which that gas emanates a health menace. If the individual is suffering from these symptoms because of a sufficiently high concentration of gas so that the symptoms are actually the result of toxicity, yes. If it is the result merely that the individual has a very nervous temperament and is easily upset by stimili which, to the average individual, would not cause any disturbance, then I would hardly say the gas was causing ill health in that individual. He might be nauseated, he might even vomit.

With the assumption that in a community it affects generally the people in the same way, causing nausea, vomiting and lack of sleep, and was carried on over a period of time of, say, fifty days, I would say that it was a health menace.

2484 I am simply familiar from my own experience with the fact that one-tenth part per million is the accepted chlorine treatment for water. I am always dealing with water-borne outbreaks and so on, and that is a figure I know that is frequently given as the desired residual at the point of distribution, that is, one-tenth to two-tenths parts per million. I believe frequently
2485 they put in two-tenths to be sure. In stating that the accepted chlorine treatment for water is one-tenth parts per million I mean that I think it is generally conceded that if you have one-tenth part per million residual of chlorine in your drinking water at the point of entrance into the mains of the distributing system that is considered sufficient to kill the usual pathogenic organisms. That, of course, is after the water has been filtered.

2486 I don't know how much would have to be applied before you get the residual. That would vary, of course. By "residual" I mean the amount of chlorine that you would find by the orthotolidin test.

2487 I have heard from time to time that five-tenths parts per million is the accepted chlorine treatment for sewage effluent. I think that is one of the standards that is used. I have never checked up the amount of chlorine applied to sewage works effluents. I do know, however, that the typhoid bacillus is very susceptible to chlorination.

2488 I said five-tenths parts per million after a 15 minute contact with this sewage effluent was sufficient for a primary sewage works effluent. I don't know how much

would be applied. It would vary according to the sewage, undoubtedly. I do not know what range it would be. That is not within my province. I was down at Brandon Pool yesterday (September 24th). We left Chicago right after lunch, I presume around one, two o'clock. We caught the five twenty-five train back from Joliet so I think that gives you an approximate idea.

2489 I presume we took about three-fourths of an hour to an hour altogether going back and forth and across in Joliet, up at the pool and back again and into the city. We traveled by automobile, but we got out at these points.

The Master

2491 I have never in my experience heard of germs being wafted through the air from a polluted stream. I agree with the testimony by other doctors that the only possibility of health trouble from this stream would be either by the drinking of the water or by swimming in it. The suggestions in the testimony of the doctors at Joliet that nose, throat and sinus ailments had been experienced because of the fact that there were streptococcic germs in the water of this polluted stream does not fit in with anything in my professional experience.

DR. JOSIAH J. MOORE

Direct Examination By Mr. Naujoks

2649 I am located in Chicago, Illinois. I am a physician and pathologist. I graduated from the University of Montana, A. B. 1907. I am assistant in research with Dr. Ricketts at the University of Chicago. Was Fellow

in pathology 1909-1910 and assistant in pathology at the University of Chicago in 1911-1912. Graduated from Rush Medical College 1912; Master's Degree from University of Chicago in pathology in 1915; taught pathology and bacteriology at the University of Illinois from 1913 to 1921; was director of National Pathologi-
2650 cal in Chicago from 1921 to 1936; director of the Moore Clinical Laboratory from 1936 to the present. I worked with Mr. Jenkins in examining the culture plates exposed to the air in the vicinity of the Illinois Waterway at and near Lockport and Joliet. I found the bacterial forms on the plates as indicated on Opponent's Exhibit No. 7. On these plates we found Hay baccillus; also
2651 diphtheroid bacilli, which is non-pathogenic and are non-disease-producing and may be found any place; and we found molds and streptobacilli and some staphylococci. Some forms of staphylococci are pathogenic, but these were of the large type, grew very readily and we did not think they were pathogenic. These are the usual bacteria one might find in air any place. Some of these tests made July 16, 1940, were made at points
2652 away from the waterway. It is my opinion that all the bacteria which may be found in scum on the surface of a polluted waterway would not be blown away in such a way that they would cause a hazard, producing disease to people along the waterway. No epidemic could occur or break out in a community adjoining a waterway containing untreated or partially treated sewage as a result of the transmission of germs or bac-
2653 teria from such a waterway by air. It is my opinion from my analysis of the air in the vicinity of Joliet and Lockport along the Illinois Waterway, that there

is no danger to the health of the people along that waterway.

Examination by The Master

2654 It was suggested to us that we take tests beside the waterway, over the waterway, in places on bridges and 2 or 3 miles on either side of the waterway. Strep-
2655 tobacilli, Key No. 3, was at a point about 4½ miles east of Joliet. Streptobacilli is not a source of disease. You may find staphylococci in any air. I considered them not pathogenic.

Cross-Examination by Mr. Wallenstein

2656 If there were pathogenic bacteria, insects and flies lighting on these sludge banks might carry it.

Examination by The Master

2657 Flies would usually alight on solid material on the surface of the water. If there were germs on the material they would get them on their feet and carry them on their feet. Flies would have to carry that material to food which was eaten by people. Typhoid fever is the common disease resulting. There is no basis for any suggestion that germs from this water
2658 might cause streptococcic infections in the throat or nose. If you had an epidemic of streptococcus infection, it would be due to contact carriers and not by any water. If it was from sewage, then you should

constantly have an epidemic of streptocuccus sore throat in that locality, and that can be easily checked up and determined whether it is constantly there or whether it is just like we find it in any other city or community not in contact with the canal or not in contact with exposure to this material. You could not get streptococcic sore throat through odors. Streptococci would have to be in the sewage and you might get it from a person having the streptococcus enteritis and then the individual would drink that and get those streptococci in his throat. You could live along the
2659 banks and breathe the air all your existence and would never have to worry about getting a streptococcic sore throat.

Cross-Examination by Mr. Wallenstein

2764 Mr. Jenkins took the tests, brought them in, and I examined them with him. The plates in the tests would indicate only air-borne bacteria. If insects got on the plates it would tell what was brought by the insects, but we were out for air-borne bacteria primarily. We
2765 could not find any evidence of any insects or flies on the plates. Unless the sludge banks contained pathogenic bacteria that was blown on tne plate it wouldn't be reflected in our test. It would have to get into the air and get over to the plate through the air. The stream or sludge banks could contain a large amount of pathogenic bacteria on the day these tests were made and it would be possible for some of the bacteria to be carried by flies and insects. If the insects had walked

upon any of the material that bacteria would be carried. I could not give the exact amount of B. coli con-
2768 tained in the stream and sludge banks where these tests were made. I do not have an opinion as to whether or not the sludge in the stream would contain any pathogenic bacteria. With the exception of B. coli, B. coli is considered pathogenic, but it is non-pathogenic when our colon is filled with it, but if you get the coli out into other tissues you will have an infection from the B. coli. Other than B. coli we would
2769 have to prove that there were pathogenic bacteria in the stream. The name bacterium coli is given to that organism which is found in the intestinal tract of man and the lower animals in large quantities, and when it is in its proper place it is non-pathogenic.

Examination by The Master

There is no other source of danger from it besides the instances given. If it gets into the blood where it could be carried you could have abscesses in various
2770 parts of the body due to the B. coli, but other than that we very seldom find it except as secondary to other infections where we may have a peritonitis due to some other organisms. B. coli, due to injury to the intestinal wall, may get through and might make it worse. You might B. coli in lymph nodes if cultures were made or you might find it in arthritis sometimes where looking for other organisms. You might have B. coli introduced by injection if you had B. coli on a needle giving an injection. If you didn't give it by

2771 penetrating the skin you would have to have it in through your mouth. Say you had an instrument contaminated with B. coli and a doctor giving an injection of vaccine or something like that and the coli organisms were on the needle or had a vaccine that had live coli in it, you could get an abscess. You could not get it by breathing the air over this Waterway.

Cross-Examination by Mr. Wallenstein

B. coli is the indicator of fecal contamination and tests are made to show whether water is palable or drinkable. If the water in Brandon Road Pool had from 10,000 to 40,000 B. coli per cubic centimeter it would indicate the presence of fecal material or the water was in contact some way or other with fecal matter, but it
2772 would not indicate pathogenic bacteria. There is no criterion on the amount of B. coli to be contained in a cubic centimeter of water that would indicate the presence of pathogenic bacteria. Any B. coli in water makes it dangerous for drinking and the standard test we use is 10 c.c. of water for the amount. So if we find any B. coli in that 10 c.c. water it isn't fit to be taken for human consumption. I did not make any attempt to determine the amount of hydrogen sulphide in my test.

Redirect Examination by Mr. Naujoks

2773 We have no test by which we can differentiate the coli that might get on the feet of the fly in these various locations, such as sludge or scum or garbage dumps or farm yards or fertilized fields or privies or other places

where decomposing organic material is present. Assuming that flies carried pathogenic bacteria such as B. coli to the food of some individual so that he might be contaminated, I could not determine whether that came from the Canal or where it was.

ROBERT C. JENKINS

Direct Examination by Mr. Naujoks

2639 I reside at Glen Oak Acres, Glenview, Illinois. I am a clinical laboratory technician. I have been working at that occupation about 16 years. I had about six months training in a hospital at Baltimore, Maryland prior to that time. I have made tests of the air in the vicinity of Joliet and Lockport along the Illinois Waterway. (Opponent's Exhibit No. 7 offered and received in evidence, pages 2641 to 2646.)

2647 We took 22 prepared plates, 11 nutrient agar and 11 Sabouraud's dextrose agar, and exposed these plates in the location specified by removing the cover of the plate and leaving the surface of the agar exposed to the air. We exposed plates at five locations on the west bank of the canal and river from Lockport to Joliet, and five plates on the east bank of the river between Lockport and Joliet, and six locations about seven miles west of the canal and the river, and six plates about four miles east of the canal and river, scattered along a line opposite Lockport to Joliet. I made these tests July 16, 1940. After proper exposure we took
2648 them back to the laboratory. We then put them in an incubator at body temperature for 48 hours. Then we

examined the plates and made counts of the colonies of bacteria present on each plate. The bacteria forms indicated on the exhibits (Opponent's Exhibit 7) are the ones found at the several plates which were exposed during the time indicated and at the locations indicated. Dr. J. J. Moore worked with me on the examination of these plates.

Direct Examination by Mr. Naujoks

Witness identifies locations indicated in Opponent's Exhibit No. 7 (p. 2722 to 2724).

2724 Cross-Examination by Mr. Wallenstein

I would judge that these tests were taken just for the purpose of determining the amount of bacteria that is air-borne and to make bacterial counts in an area along the river between Joliet and Lockport and from 5 to 10 miles away from the river. The only bacteria
2725 that could be reflected on the slides would be blown on by the air or carried by insects. We made a microscopic examination of smears from colonies selected from the plates. In one case out of all these tests I saw some form of insect on the plate, and this was away from the pool. I did not make any actual slides of the sludge or scum deposits in the river to determine what
2726 bacteria was present. My tests were to determine the bacteria in the air. I can only say that insects do carry thousands of bacteria on their feet from what I have read in newspapers and if that be true and insects

had come across those slides you would have thousands and millions of bacteria and we would expect a higher
2727 count on the plates. These tests were not made to in any way determine any hydrogen sulphite content in the air. They would not reflect anything as to the composition of any gaseous odors given off.
September 23, 1940

Direct Examination by Mr. Naujoks

2145 DR. NORBERT ENZER. I live in Milwaukee, Wisconsin. I obtained my Doctor's degree of Medicine at McGill University in Montreal, Canada in 1923 and then spent four years in post-graduate work in New York and Chicago and in April 1927 I became the Director of Laboratories at Mount Sinai Hospital, Milwaukee, and I have been director of those laboratories since then. In addition to that I have been engaged in
2146 private consulting practice for the past seven years. In a casual way I am familiar with the order of the United States Supreme Court dated April 3, 1940 appointing a Special Master to make summary inquiry in this matter, and I am familiar in a general way with the Sanitary District Canal and the Illinois Waterway and the Brandon Road Pool at Joliet. We drove along and around it today (September 23, 1940).

2148 It is my opinion that any odors that might at any season be given off by that canal would not constitute a menace to health. It is my opinion that if that waterway was used for drinking or bathing it would constitute a menace. If it wasn't used for drinking or bath-

ing or physical contact with a human being I don't think it is a menace.

2149 Assuming that the Illinois Waterway is not used as a source of domestic water supply by any of the communities along such waterway, and that such waterway is not generally used for bathing or other recreational purposes at Joliet it is my opinion that such waterway would not constitute an actual menace to the health of the inhabitants of Joliet and Lockport merely by reason of the fact that such waterway flows through the City of Joliet. One reason for my opinion is that any source of this kind would have to be judged, so far as its menacing qualities are concerned, by the history of its effects. It is a menace if it has produced ill effects. If over a period of years sufficiently long to allow for the mathematical corrections incident to
2150 an epidemilogical study such ill effects have not been shown, then such waterway wouldn't be a menace.

Then one could approach it from the standpoint of whether incidental accidents might occur, occasional accidents might occur from such a polluted stream. For example, at one point in the canal a break might occur and water might seep into the soil and somebody might be tapping a well later on through that soil. That would be an accident and would constitute a menace and hazard to health, but it would be due to something not inherent in the merits or demerits of the waterway. It could happen in any structure of that kind. It could happen in a sewer. It could happen in a city waterway.

How this thing would constitute a menace, I think is fairly simple. It must produce a contact infection. In other words the individual must consume the water,

or he must bathe in the water, or it must contaminate dishes or kitchenware, but other than that I don't think that it would constitute a menace to health because I don't believe there is any evidence by which we can determine that there are air-borne diseases from a structure of this kind.

2151 Air-borne diseases, as a general rule are not derived from moist surfaces. They are more generally derived from dry surfaces. So, outside of the discomfort or annoyance of an odor to which one might not be accustomed, I don't believe there is any menace to health. Odors can be annoying; they can be a source of discomfort; they can produce even symptoms on occasion, but they are transient and they are evanescent, they don't cause a disease, they don't undermine health and, as a general rule, people who are constantly exposed to the same odors rapidly become adjusted to them so they very soon become less conscious of it and finally do not notice it at all.

2151 It would be impossible for that Waterway to project bacteria into the air from the scum which may be found along the sides of the Waterway or the walls of Brandon Road Pool. It hasn't any propulsive force of its
2152 own; it isn't a spray. Bacteria do not fly. They have to be carried away and wherever there is a moist surface, and particularly a gummy or sticky surface, bacteria are less apt to get loose. They are more apt to stay on such a surface. They flourish and grow there —that is, certain kinds of bacteria do, and when we use the term "bacteria" you must remember that not all bacteria are harmful or pathogenic to the human. Some are very beneficial and to use the word "bacteria"

in its inimical sense I don't think would be giving the right impression.

I have read the testimony of Dr. Frederick in this case. I do not agree with his opinion as to the effect of the Waterway upon the health of the inhabitants of Joliet.

2153 It is my opinion that increasing the diversion of water from 1500 cubic feet per second to a total of 5000 cubic feet per second, plus domestic pumpage, wuoldn't affect the menacing qualities of that stream, if there is a menace there.

Cross Examination by Mr. Wallenstein

Today is the first inspection I have made of the canal. It is the first time I have ever been that close to it. I have driven by it on a number of occasions, but never with this sort of thing in mind. We didn't make any tests; we simply looked at it. An odor was perceptible today; I would describe it as the odor of oil.

2154 I did not notice any sewer odor. The nearest thing to a sewer odor came, I believe, at the Brandon Pool. There was a garbage heap on the south of the canal, just off the bank of it. There was a very distinct, malodorous quality of the air there, but other than that I didn't notice any. I am not a toxicologist, but toxicology forms part of my practice. I don't like to consider myself eminently qualified as a toxicologist. I have had experience with the effects of gases on the human organism. I said that I detected an odor of oil and that, I think, perhaps, answers your question as to

what various elements constituted the gas given off by this canal. I didn't detect any odor of gas.

2155 There is a mixture of fumes in the odor ordinarily given off by a stream which carries raw sewage. There are sulphide compounds, nitrogenous break-down, methane. I don't think that one could limit them except to say that they belong to the results of the breakdown of nitrogenous material.

No, I don't think the odor I smelled today was resultant from any sewage. It didn't suggest that to me at all. If the canal gives off such an odor I haven't experienced it. If it did give off such an odor hydrogen sulphide would be one of the gases given off; methane would be another gas.

2156 I would hazard the guess that hydrogen sulphide would be a very low percentage of such a gas. I wouldn't want to state an approximate figure because I don't believe one could arrive at a figure of that kind unless one made a large number of tests over a sufficiently long period of time. Excluding carbon monoxide, I have never run into any actual cases where there have been tests made as to the effect of sewer gases upon populations in any other cities. I am not familiar with tests made in Paris as a result of the sewer gas. I would use the word "menace" with respect to health as applied to something which was actively a menace. In other words, it would pronounce deleterious effects to health to a sufficiently large number of people who came in contact with it so that one could say that it eliminated the accidental factor of some particular or
2157 peculiar individual's susceptibility.

To give an opinion as to what effect a sewer gas odor would have upon the population in Joliet if the same was given off for, say, periods of three to four weeks constantly, I think you would have to lay before me the extent of the penetration of the gas into the community, the constancy of its flow, the amount of flow. It would all be important. One must distinguish between an odor and the sewer gas. I am testifying in answer to the questions that were given me and I did testify that I hadn't detected any sewer gas. The only odor I detected is that which I describe as nearly as possible as the odor of oil. I detected no hydrogen sulphide.

Mr. Clausen

2158 The only familiarity I have with the Sanitary Canal is the result of an inspection trip I made today, plus a map that was given to me, and a transcript of some of the testimony that went on here, and a statement of the problem involved. I don't know anything about the bio-chemical oxygen demand of the Sanitary Canal. I don't know anything about the number of colon bacilli that are located in the water of the canal. I don't know anything about the pyogenic cocci or the staphylococci or the streptococci that are in the canal. If a stream were heavily polluted with those bacteria or germs that would have no bearing on my testimony.
2159 As a matter of fact I answered it fully in the belief that that stream was heavily filled with bacteria. I simply assumed, because of the very nature of the stream, that it would have a high bacterial content. I

don't think that would affect my answers at all irrespective of the number of count or anything else.

The Master

I am a Director of Laboratories at the hospital, labeled as a pathologist and in my department I have charge of all of the investigations that go on in the hospital which involve bacteriology, serology, chemistry, toxicology, examination of tissues, and so forth. My practice is to advise doctors with respect to questions which may come up in the examination of specimens or patients and so on.

2160 It is my opinion that if this water is not used for drinking or bathing, there is no likelihood that people would be made sick, and I am assuming that the B.O.D. is high in this water.

2161 It did happen in the past that Chicago didn't treat its sewage and dumped it all untreated, and I don't think the records show that any ill health resulted from it, and we have situations all over this country where open sewage, untreated sewage, is dumped into open streams, and even water taken from those streams for drinking purposes and still it hasn't been established that constitutes a menace to health, providing the water used for drinking purposes has been filtered and treated. If by calamity the sewage system of any large city were destroyed by bombs or otherwise, and you had a lot of untreated sewage, pestilence might ensue. It would ensue because such untreated sewage would contaminate drinking water or food, and only in that way.

2162 If the Supreme Court had said "We won't allow any time, even though you haven't got your treatment plants constructed yet; we won't allow you to take any water from Lake Michigan" nine years ago, then Chicago would have had to dump all of its sewage out on some open territory. That would constitute another type of danger. When you are dumping sewage out into open territory then you are permitting a type of proliferation of insects and lower animals which would permit the dissemination of a disease by insect carrier, which doesn't obtain in this sort of thing we are talking about today. That is why I pointed out that there was a garbage heap on the bank of this canal, which I considered far more important as a possible menace in that particular little sphere than the water itself. The explanation of the Health Commissioner of Joliet as to how this might be a health menace because of insects, flies spreading disease from the sewage in the canal would not tie up with what I have just said for several reasons. One is that sewage that is in that canal has been converted and partially oxidized and
2163 probably to a very great extent has been oxidized. Secondly, there is an oily film on that water. A scum forms from the sewage. The bacteria that are in that sort of material are not the bacteria that have pathogenic qualities. Those have been destroyed long since. I don't think flies lighting on the surface of that water would pick up anything very damaging to carry away and deposit on people's food or hands or that sort of thing.

In the case of flies picking up bacteria from sewage dumped out on an open area of land that could be made

a source of illness by their flying to kitchens, restaurants and food shops and bakery shops and open-air vegetable stands, light on them, deposit the bacteria there, and finally carried on to where the human being consumes them. The only way this can be made a source of illness is by this being taken in by some injection process into the human body by eating or drinking, and also by bathing. Contact with the skin can produce ill health
2164 too. It can produce inflammations of the skin and diseases of the skin. Then too, contact with the skin makes it possible for an individual's hands to become infected with material and later on the material on the hands is transferred to food or on to the mouth and eyes and so forth and produces disease. I don't think a sting by a fly that had alighted on a sewage dump would produce a skin disease. I am not personally aware that a disease has been transmitted to the skin by direct contact of the fly. I think it is almost entirely contamination of food or the utensils that are used in the preparation of food.

I don't think it might happen that a fly alighting on untreated or partially treated sewage coming into this stream every day from the Sanitary District might carry disease because that material would be down at the bottom of the stream when it is fresh and the material that comes up to the top is the less harmful material. The new material is heavier and is apt to be at the bottom.

2165 The material at the top is unsightly and not very attractive from an esthetic point of view, but I don't think it is nearly as harmful as its bad looks might indicate. I don't think my answers would be any differ-

ent if there were not oil in this waterway, as to the spread of disease. I merely mentioned the oil because it was the odor of the oil that I detected. Secondly, it was visible on the surface of the water. There is a further reason for my being of the opinion that flies would not spread disease from this waterway. The main fly that is responsible for the transference of bacteria in the sense that we are talking about is the common house fly.

2166 The common house fly lays its eggs in refuse deposits; it doesn't lay them on the water; its habitat isn't the water, but any casual inspection will indicate the many, many thousands of times more flies there are on a refuse or garbage heap than there is on the surface of even a stagnant pool.

Assuming that there was a menace it is my opinion that an increase in the water from 1500 c.f.s. to 5000 c.f.s. would make no difference because I don't believe that the sides of the canal and the eddies and pools that form in it would be washed clear in that way. Where the canal widens out around the Brandon Pool would allow for even greater accumulation of waste products because it would come down faster through the narrow part of the canal and then settle where the canal is widened out. I am not a physicist or an engineer, but it would be my guess you would have to have many, many times more rapid a stream to wash a menace out. If I were mistaken in my assumption that
2167 this new material went to the bottom—if it remained on top—so much more would it setle where the pool widened out. To the extent that there is more oxygen in 5000 cubic feet per second than there is in 1500

cubic feet per second, the additional oxygen in the water would oxidize the content of the stream and reduce any hazard that otherwise exists.

Mr. Wallenstein

If there was a gaseous odor given off from this sewage it probably would contain hydrogen sulphide. As-
2168 suming it had 100 parts per million of hydrogen sulphide, if an individual got a pretty good whiff of it before it became disseminated into the atmosphere he would probably feel a little bit nauseated. He wouldn't like the odor of it very well. You must remember that 100 parts per million at the source is reduced so rapidly by dissemination into the air that it would probably be immeasurable. Assuming that at the point of inhallation there was 100 parts per million and this is prolonged over a period of a week, I think it would be very disagreeable. It might cause nausea in some people. Whether it would have any effect on the nervous system would be indulging in a good deal of speculation. Some people might be made irritable and nervous by it and others would not, but it certainly wouldn't constitute a state of ill health of the nervous system as a physician would
2169 understand it. I think it would be speculative whether it would have any effect on the sleep of an individual. I think if a person told me he couldn't sleep because he smelt the odor then I would be obliged to believe him, but I would have to make a statistical analysis of all the people in the community and find out how many were so affected.

If the inhalation is continued, such as one would have in a laboratory where hydrogen sulphide is escaping in a closed room, I agree with Dr. McNally's statement at page 396 of his book "Toxicology" where he says: "Concentration of hydrogen sulphide as low as 100 parts per million may cause local irritation and depression of the nervous system not unlike that following a prolonged course of bromides." In order to
2170 have a concentration of 200 or 300 parts of hydrogen sulphide gas per million cubic feet of air over a period of a week, it would be almost a physical impossibility unless one literally poured that gas through a conduit, because the escape of that gas in the general atmosphere so rapidly dilutes it. With that reservation I would say that the effects of 200 to 300 parts of hydrogen sulphide per million given off for a period of a week would have that many times the effect of a lesser concentration on the surrounding community. It would cause some depression; it would cause headaches; it would cause nausea, bad taste in the mouth; it might cause vomiting, and I think people could be made to sleep less.

2171 I agree with Dr. McNally's statement in his book that a concentration of as little as .005 to .01 per cent will cause a conjunctivitis, popularly known as gas eyes. That is a pretty high concentration. I also agree with his statement that if there was a diluted amount of hydrogen sulphide it would produce nausea, giddiness, cold skin, labored breathing, irregular action of the heart, and transient ventricular fibrillation. I agree with the statement that "In greater dilutions sleeplessness will be produced" and that "in exceedingly dilute

conditions it sometimes occasions febril symptoms somewhat resembling typhoid." If he inhaled .15 per cent of hydrogen sulphide it would produce quite a few symptoms. It might be fatal if he got a good dose of it.

Mr. Wallenstein

2172 Loss of sleep might have an effect upon the health of a person. I can conceive, for example, that the loss of sleep that is going on in London now might affect some of the people there in an unfavorable manner, but loss of sleep as an incident, I don't think, contributes to ill health, and if the thing that produces the loss of sleep at the time sleep is normally expected is continued over a long period of time, the normal individual will readjust himself and find his sleep at other times. A man who works during the day and sleeps at night will be affected if he can't sleep at night; he will be tired. Loss of sleep might have an effect upon the convalescence of a person who has been ill. It would depend entirely upon whether you could distinguish whether the loss of sleep was arising out of
2173 factors not incident to the convalescence. If it was not it could produce ill effects. Assuming again a convalescent person who was unable to eat or became nauseated from causes other than something incident to the illness from which he is convalescing, I think that would have an effect in retarding his recovery.

Redirect Examination

Mr. Naujoks

I think it would be utterly impossible to have the concentrations of hydrogen sulphide mentioned in Dr. McNally's book under the conditions obtaining at Joliet.

I say so because hydrogen sulphide is soluble in the
2174 first place and a great deal of it will remain dissolved in the water. Secondly it comes up at best in minute bubbles over a large surface and within a few feet of the surface of that water its dispersion would be so great that it could never reach that concentration.

If anybody were exposed to hydrogen sulphide I would say that the people who went up and down this stream on boats would be closer to it than anyone else.

Mr. Cohan

The chief odor that arises from sulphur baths is a sulphur odor. It has hydrogen sulphide in it. I am not so sure that the odor most perceptible to the sense of smell that arises from the putrefaction of untreated sewage in a stream is hydrogen sulphide. I think there are other odors that are just as readily if not more readily perceived by the human smell than hydrogen sulphide. The product of the combustion of nitrogenous material, the breakdown of bacterial fermentation contain other substances which I don't think we can label by a name. We simply speak of them as putre-
2175 factive odors that one will be often more pungent

and, therefore, more detectable than the hydrogen sulphide content.

With this waterway as we know it today I think any danger there would be speculative, except within the limits of the actual consumption of water. The danger or menace is not real and immediate.

Recross Examination

Mr. Wallenstein

I have never made any experiments as to the effect of the hydrogen sulphide from Brandon Road Pool.

Redirect Examination

Mr. Naujoks

2176 I have been to Mt. Clements, Michigan and French Lick health resorts where the hydrogen sulphide content in the water and the air is very high. Those are places where people go for health purposes.

Recross Examination

Mr. Clausen

I would say fundamentally my testimony has been based upon my medical education—my experience in medicine. The inspection I made today was, I think, of secondary importance. My inspection was contributory so that I could bring into play my medical training and experience. This was by automobile; we just drove around. I think if anybody had given me a good
2177 map of it or a good picture and described the conditions I think I could have answered the questions just

as satisfactorily. We left Chicago a few minutes after ten Chicago time and got back to the Loop about one o'clock. The actual driving time took about an hour. September 23, 1940

Direct Examination

Mr. Naujoks

2178 DR. EDWARD RICHARD KRUMBIEGEL. My residence is Milwaukee, Wisconsin. I am Commissioner of Health of the City of Milwaukee. I received my M. D. degree from Marquette University in 1935. I was instructor in biochemistry at Marquette University School of Medicine in the school year of 1930 and 1931. I served my interneship in the year 1934 and 1935 in Gorgas Hospital, Encon, Panamal Canal Zone. I was in the United States Public Health Service at the United States Marine Hospital, Memphis, Tennessee from 1935-1936. That is from July to July. I was resident physician in St. Luke's Hospital, Milwaukee from October 1936 until January 1937. I was Director of the Bureau of Communicable Diseases in the Milwaukee Health Department from January 1937 until July 15, 1940, and I have been Commissioner of Health since July 15, 1940.

2179 In a general way I am familiar with the order of the Supreme Court dated April 3, 1940, appointing the Special Master to make a summary inquiry in this case. In a general way I am familiar with the Sanitary Canal, the Illinois Waterway and the Brandon Road Pool at Joliet. I made a personal inspection trip of the Sanitary Canal and Brandon Road Pool at Joliet today.

It is my opinion that no odor emanating from the Illinois Waterway in the region of Joliet or Lockport directly and solely of itself is the cause of any disease in the people living along the waterway.

2180 As I have observed the Illinois Waterway today I do not believe there is an actual menace existent to the health of the inhabitants of Joliet and Lockport, but there may be a potential menace under certain conditions. Those conditions, however, are not operative at the present time. Assuming that the water from the Illinois Waterway is not used for domestic purposes or drinking purposes by the inhabitants of Joliet and Lockport and that such waters are not used for bathing purposes by such inhabitants, I believe that the Waterway does not constitute a menace to the health of the people living along its course.

Cross-Examination

Mr. Wallenstein

I have never before today seen Brandon Road Pool.

2181 We drove along the course of the Pool from its end at the Lockport locks, I believe it is, to the end where the locks are distant to the City of Chicago. Then we stopped along the side of the pool, climbed up on the retaining wall or the banking wall of the pool to observe the water and the odor. We also stopped for a short period along the course of the river just below the locks at the distal end of the pool.

We didn't perform any experiments while we made our visit and inspection. We observed the surface of

the pool and the odor of the air in the immediate vicinity of the pool. The odor was distinctly that of oil. There was also, in some places, a faint, what I would call, musty odor, such as we frequently are able to detect along the course of bodies of water which are stagnant and in which there is some decaying organic matter.

2182 There was no odor there of sewage. There was an odor that might have been due to, and I believe was due to, putrefaction of nitrogenous material. That same odor could be reproduced by allowing leaves to undergo decomposition partially and then throwing them into water. I didn't detect any odor there that was distinctly that of sewage in contradistinction to other odors emanating from putrefying organic material other than the odor of garbage which had been deposited along the bank of the river just below the pool. Insofar as I have been able to smell them on many occasions, I am familiar with the composition of the gaseous odors ordinarily given off by sewage putrefaction. I have never made any chemical analysis. Many volatile substances undoubtedly get into the air from
2183 sewage. I am not familiar myself with any study that has been done to break down the odor itself into its various component parts. Hydrogen sulphide is one gas that is sometimes discernible in the presence of seweage.

My opinion as to the effect upon a person who inhaled gaseous odor of which there was 100 parts per million hydrogen sulphide is that a concentration of 100 parts per million of hydrogen sulphide in the air is a rather high concentration of the gas, and under such

circumstances a person might suffer discomfort. He might be made ill, depending on the person. Some people could, undoubtedly inhale a higher concentration than others without being made ill. Hydrogen sulphide poisoning is not a communicable disease, and it is correct that any effect upon an individual from hydrogen sulphide poisoning would not be reflected in any table of communicable diseases.

2184 When I made the statement "It is my opinion that no odor emanating from the Illinois Waterway in the region of Joliet or Lockport, directly and solely of itself is the cause of any disease in the people living along the waterway" I meant by "disease" any disease.

2185 I would include all disease under that statement as not being caused directly and solely by odors which might arise from the Ililnois Waterway. As a doctor I would call hydrogen sulphide poisoning a disease.

The effect upon a person inhaling 200 to 300 parts per million of hydrogen in the air would vary to some extent with the person that was inhaling the gas; but generally speaking, it would probably cause nausea, it might produce vomiting. If the exposure was long continued it might result in headache, depression. If it was continued long enough derangement of the temperature controlling mechanism of the body might result, as well as derangement of the cardiac, heart controlling center.

2186 If a person suffered from nausea and the various symptoms I have mentioned, and those symptoms result from inhalation of a gaseous odor, I would say that the source from which there odors emanated were a menace to that individual's health.

Mr. Clausen.

As to there being a possible menace to the health of the communities along the canal, the hazard in case of the occurrence of unusual conditions would be materially greater in proportion to the increase in pollution of the Sanitary Canal. For instance, if an individual was to inadvertently drink some of the water, the hazard would be greater in proportion to the increase in pollution.

The heavier the pollution the greater the possibility is that there would be higher concentration of hydrogen sulphide, but I would find it difficult to conceive of this Illinois Waterway giving off so much hydrogen sulphide as to cause illness in the people residing along the course of the Waterway. The more polluted a stream is, the more possibilities there are of there
2187 being more hydrogen sulphide given off. The greater the amount of water, the greater the dilution of the sewage, and the less possibility of there being so much hydrogen sulphide given off. My inspection trip was the same as Dr. Enzer's. We left here around ten o'clock and got back around one o'clock. We crossed the Sanitary Canal at a number of points but we stopped at those two places at Brandon Pool to get right up next to the water. The two places I have reference to are the ones I mentioned before—one
2188 along the embankment of Brandon Road Pool, I should say approximately 1000 feet this side of the dam at the distal end, as well as the wall of the river about 800 or 1000 feet beyond the dam. As near as I can orient myself after driving around it seemed

to me that the wind was blowing from a southeasterly direction. It may have been south. At least as we were driving along the west bank of Brandon Pool the wind was coming across the pool toward us as well as along its length.

I have no knowledge as to the number of colon bacilli in this canal—no figures from any laboratory to support it, but I would assume that the colon index
2189 in the water there is quite nigh. I do not know what the amount of pyogenic cocci or staphylococci or streptococci there are in the canal. I don't know anything about the biochemical oxygen demand. I have heard these articles from Dr. McNally read as to the effect of hydrogen sulphide upon the human person, and I agree with those statements.

The Master.

2190 It is my opinion that as long as this canal is not used for drinking or bathing there is no potential menace to health. I would want to qualify this statement about drinking to also cover, as another potentiality, the fact that it might get into wells under certain circumstances. If you exclude the possibility of the water being used for drinking or bathing I would say there would be no potential menace from the presence in this stream of partially treated or untreated sewage.

2191 I was asked whether there would be more hydrogen sulphide in the air now than if the amount of dilution was considerably increased. It is my opinion that that statement is true when we consider the

entire Sanitary Canal. If the amount of flow was increased, the amount of available oxygen would be increased, but that would not necessarily mean that there might not be a higher concentration of obnoxious gas at any one particular point. If the velocity was to be increased in a narrow channel and then we broaden out that channel, the settling will occur there, whereas with the lesser velocity it might occur up farther.

2192 From a health standpoint the presence of hydrogen sulphide in the water, assuming the water is not drunk and is not used for bathing, would have no health significance whatever as long as it remained in the water. If it got into the air that would all depend on the concentration. As the gas would arise
2193 to the surface, it would, of course, be diffused immediately into the atmosphere and people could develop symptoms from hydrogen sulphide only if there was enough hydrogen sulphide in the air to affect them and that, of course, would vary to a considerable degree with the individual. Some people might find the fecal material of cows very obnoxious and yet we have millions of farmers that live in and around such fecal material every day.

There very likely would be some hydrogen sulphide present in the regions of dumps, the region of packing plants, especially if they were not kept in sanitary condition. In other words if the intestinal material was allowed to lie about and putrefy, such odors might occur.

2194 The amount of hydrogen sulphide would have to be pretty great to bring about derangement of con-

trol systems, cardiac control systems, and brain control systems.

There are no available figures that I know of, of experience as to epidemics having been caused solely by hydrogen sulphide in the air. These statements read to me from this textbook merely went to the extent of saying that there were cases on record where hydrogen sulphide might produce the results described. Such a set of circumstances might easily arise in a laboratory where a man was generating hydrogen sulphide to be used in some particular experiment. There the concentration in the air might get up to a rather high level. I do not know of any recorded cases where illness among a substantial number of people has been traced solely to hydrogen sulphide in the air.

2195 I think in that connection we must remember, too, that when we speak of nausea, loss of appetite, and things of that type, we are speaking of symptoms which are not open to proof of any kind. If we find an individual vomits we have objective evidence of of his vomiting. We know he vomited. I could say now that I have a terrific headache and nobody in the world could prove or disprove that I have or have not that headache. If he vomited today and didn't vomit after today I would say he wasn't sick, but if he vomited every day it might produce serious results, and if a number of people vomited every day that would be quite a serious situation from the health stand-
2196 point. If I were of the opinion that the presence of this sewage in the canal might any day cause a considerable number of people to vomit every day I would consider it a serious health menace.

Mr. Clausen.

It is possible that hydrogen sulphide can be given off from a polluted stream of water. The temperature of the air and the temperature of the water would have some bearing on that. Bacteria, for instance, in fecal material comprises a considerable percentage of the total solids in the feces, and in the destruction of such bacteria certain protozoa are brought into play in
2197 the water. They ingest them. In fact the bacteria serve as a food for certain types of protozoa. The protozoa are much more active in warm water than they are in cold water. They propagate more rapidly as well as being individually more active. On the other hand, the colder water is, the more oxygen it can retain. As we heat water we will drive the gases dissolved in it out until after we boil it a while we have driven off all the gases in the solution. The warmer the day the more apt there is of hydrogen sulphide being given off.

Redirect Examination—Mr. Cohan.

2198 The most important odors given off at these sulphur baths would be that of hydrogen sulphide. I believe that is the one most perceptible to the sense of smell. It is my opinion that the present conditions along the Illinois Waterway do not constitute a real and immediate menace or danger to the health of the people.

Mr. Naujoks.

2200 I don't believe that under the present circumstances it would be possible for the Illinois Waterway to cause a concentration of 100 parts per million of hydrogen sulphide.

The Master.

By "present circumstances" I meant the way that it is presently being operated. That is irrespective of today or tomorrow or the next day. What I had in mind was this: that if the flow of water was to be stopped altogether, and it was to be drained and this
2201 sludge left to rot at the bottom, it might be possible —I even then would doubt it—to get a lot more hydrogen sulphide in the air than under the present circumstances. I am not basing my answer on any detailed information as to how much untreated sewage there is, or what the B.O.D. of that water is. What I had in mind was that if that thing was to be drained and covered over, then the air in this enclosed space might reach that concentration, but as long as it is open to the air where the gas can diffuse into the atmosphere, I don't believe it could ever reach that concentration.

Mr. Naujoks.

2202 The hydrogen sulphide would be diffused very rapidly in the air. I wouldn't be able to say whether there would be much hydrogen sulphide around oil refineries or not.

Recross-Examination—Mr. Clausen.

2203 I couldn't identify the particular volatile oils in the oil as a whole or low boiling temperature that I smelled out there today. Oil doesn't consist of any one particular thing. It is made up of many different molecular substances. I don't believe I could break down these gaseous odors that I smelled down there because I don't know what substances have been taken off from this oil. For instance, I don't know whether there is butane in the oil, or pentane, or octane, or heptane, or any of those substances, but I do recognize the odor of oil as a composite substance.

2204 The type of odor I am referring to would be just the same as if we had a gallon of oil here and we smelled of it.

Mr. Wallenstein.

The hydrogen sulphide given off in the gaseous odor emanating from a sewer doesn't necessarily mean from sewage, because I have smelt this musty odor emanating from storm sewers.

2205 Hydrogen sulphide given off in the gaseous odor from a sewer in which there is human fecal material comes from the decomposition of organic substances containing sulphur. Certain bacteria in the intestinal tract contain sulphur. Many of the substances we eat like eggs and onions and so forth contain sulphur. Meat contains sulphur. The hydrogen sulphide that is given off in this gaseous odor can emanate from the human fecal matter in the sewage in the stream,

but that isn't the only source of that odor. There is
2206 urine and oftentimes sanitary napkins go down in sanitary sewers; under certain circumstances blood might go into them and so on, and offal from slaughterhouses, and blood from slaughterhouses, waste material from canneries. I presume those materials go into the Sanitary District Canal here the same as they do elsewhere.

I have never made any analysis of the chemical composition of the gas given off from a sewer used to dispose of human fecal matter. The approximate amount of hydrogen sulphide that would ordinarily be contained in such gases would depend on the sewer, whether it was an enclosed sewer or whether it was an open sewer. If it was an open sewer so it could diffuse into the air the concentration would never reach a very high level. If it was absolutely closed so it could not diffuse the concentration of the gas might reach an appreciable level. I don't believe I could answer the question how high a level it might reach
2207 assuming it was a closed sewer because it would depend on the amount of organic material that was available for decomposition. It certainly is possible for a man to die in an enclosed sewer, but those deaths are usually due to methane and I could not say whether they could or could not be due to a sufficiently high percentage of hydrogen sulphide. I couldn't tell you exactly how long it would take for a man to become asphyxiated as a result of 3000 parts of hydrogen sulphide, but I presume it wouldn't take a very long period of time, possibly a matter of minutes.

2208 If the atmospheric pressure upon gaseous odors were decreased the rate of diffusion would be increased.

DR. EDWIN B. GUTE.

Direct Examination by Mr. Naujoks.

2209 My name is Edwin B. Gute; I live at 5630 North Lake Drive, White Fish Bay, Wisconsin.

I received my Bachelor of Science degree from the University of Wisconsin in 1923, and my M. D. degree from Rush Medical School in 1925. I did some residence work at Presbyterian Hospital in Chicago, in Milwaukee Children's Hospital, Milwaukee and in the Milwaukee Hospital. In 1926 I began the general practice of medicine and surgery at White Fish Bay, Wisconsin. I have been Commissioner of Health and Director of School Hygiene of the Village of White Fish
2210 Bay since 1927 and in the same capacity for the Village of Fox Point since 1934. I am chairman of the Milwaukee County Associations of Suburban Health Commissioners.

I am familiar with the order of the United States Supreme Court of April 3, 1940, appointing a Special Master to make a summary inquiry in this case.

I am familiar in a general way with the Sanitary District Canal and the Illinois Waterway and the Brandon Road Pool at Joliet.

It was stipulated that Dr. Gute would testify the same as Dr. Enzer and Dr. Krumbiegel.

Part Two

TESTIMONY OF WITNESSES AT JOLIET AND TESTIMONY OF DOWNSTATE WITNESSES

Testimony of Medical and Lay Witnesses
at Joliet Illinois

July 22-25, 1940.

July 22, 1940

290 GEORGE T. JONES, Mayor of Joliet since 1935. Resides at 356 Whittier Avenue. I observe the Waterway almost daily. There has been a decided change
291 in its physical appearance since January 1939. There would be no change noticeable to the casual observer during cold weather, but in April and May of 1939, after a protracted warm spell there was a greater disintegration of sewage as evidenced by the sludge on the surface of the water. I believe that the period of May 1939 was the wost period that we have gone through. There was more sludge accumulated on the surface and there was a more offensive odor from it than at any time.

292 My home is about a mile west of the river. I have
293 observed the odor at my home quite strongly. I would describe the odor as that of a heavy sewer gas more than anything else. I have received plenty of complaints during my term as mayor about this odor. The first complaints where they became numerous at all was along in the spring of 1939. During May there was a constant stream of complaints coming into the City Hall. I associate the odor with hot weather.
294 The sludge that is accumulated on the bottom will not disintegrate and pass off as gas in cold weather to the extent that it does in warm weather. The stench

is constant. It is always present after a warm spell.

I have resided in Joliet fifty seven years. The sew-
295 age of the City of Joliet enters into the channel below the Brandon Pool. We have no sewage depot at this time. We have a population here of 43,000. Our drinking water is obtained from deep wells. We don't use the Illinois Waterway for drinking purposes. I was not sick last year (1939). Brandon Pool was com-
296 pleted I would guess along in 1934. Prior to completion of Brandon Road Pool that section of the Illinois Waterway from Lockport to the Brandon Road Bridge was a narrower stream and the velocity would be greater with the same amount of water going through. To the best of my knowledge all of Chicago's raw sewage flowed through Joliet prior to the completion of the Brandon Road Pool and prior to the completion of the walls (of the pool,) all of Joliet's sewage went
297 into the old river. There was an odor but not to the extent there is now. The odors described in my direct testimony were more pronounced in 1939. I drove across the river this morning (July 22, 1940) and it was quite smelly. You could notice a decided scum on the river between Jefferson and Cass Street bridges.
298 I always observe an odor when I come across the river, every morning this year. I have lived in that location for 24 years. I have not been able to observe odors all those years—more noticeable just the last two years. I have observed them before that in crossing the river but not at my home.
302 I didn't keep a tabulation on complaints received. There was the constant annoyance of people calling up wanting to know what they were going to do about

getting the river cleaned up. Practically all of those complaints were by 'phone. I kept no record of them.

304 There is no industrial source in Joliet from which those odors could emanate other than the canal.

305 We haven't had the conditions this summer (1940) that we had last summer (1939) for the reason that we haven't had as long a protracted warm spell.

306 We have had a warm spell for the last two or three days—the first real warm spell we have had—and it takes more than that to bring this thing up.

July 22, 1940

307 HARRY SAMPSON. I reside at 14 Marion Court, Joliet, Illinois. I am City Engineer for the City of Joliet. Have been City Engineer for right close to four and one-half years.

308 I have observed the waterway canal frequently. Late last summer (1939) there was a pronounced change, for the worse, over the previous year (1938). So far this year (1940) it has been a better condition. During a long hot, dry spell last summer (1939) it de-

309 veloped a big heavy scum on the surface. I would say it was four to five inches thick. I have seen the pool about 50 per cent covered with scum. That wasn't a constant condition—that was just a wind condition that happened to force it all down in there. I live about three-fourths of a mile west of the river.

310 We smelled an odor from the canal last night. We got a very, very distinct odor up there. It just smelled terrible at times. On a particularly bad night we don't

eat in town if we can help it. Ten days is about the longest period over which we have noticed this odor constantly.

311 I can't say the odor has injured my health, but at times it is nauseating. My wife and I are of the habit
312 of eating out quite a bit. I have resided in Joliet four and one-half years. I would say '39 was when the odor was most pronounced. Before that the river has not smelled like that since I have been residing there.

313 I have tasted the odor in my food persistently. The odor affects my sleeping and there have been times when I have awakened from the odor.

July 22, 1940

314 RAY POWERS. I live at Plainfield, Illinois. I am employed by the Joliet Material Company, located on the east bank of the drainage canal where the Rock Island crosses the river.

315 I have been employed there since 1928. I have had occasion to observe the physical appearance of the
316 waterway canal. At times since January 1939 it seems to be more offensive. Sometimes that scum will pile up as much as two and one-half inches in thickness. It seems like it is almost solid enough to walk on. I believe I have seen that before 1939. This summer (1940) I haven't. I haven't had occasion to be down there as much with my work as previously.

I saw this collection of scum in the real hot weather. It will bubble and form a gas there and you can see this material come up.

317 I haven't noticed how long this scum formation remains on the water—sometimes it is for days though. It seems to be down in the pool area—generally below McDonough Street—where this formation is the greatest. It seems to drift whichever way the wind blows. I don't know that the odor since January 1939 is more offensive than it had been prior thereto. This spring (1940) it hasn't been so bad. Last year (1939) it was terrible. The odor isn't constant.

318 It continues sometimes a day or two, sometimes all night. Some warm nights when you come in you can smell it long before you get to Joliet. I have noticed it several miles from the canal. I have noticed it in 1940, but not so great this year. It was more intense during 1939.

July 22, 1940

319 HAROLD RAUE. Mayor of Lockport, Illinois for previous 3½ years. Has lived in Lockport 41 years
320 and resides within about a half mile of canal. My place of business is about four blocks from the canal. The physical appearance of the canal is much worse in 1940 than it was prior to January 1939. At the present
321 time it is a stagnant pool. The water looks thicker now (1940); heavier and more solid than it was prior to that time. In 1939 a gassy, unpleasant, nauseating odor was given off. Odor was more intense in 1939 than prior to that time. It is worse in warm weather
322 than it is in winter or cooler weather but now (July 1940) I would say conditions are at their worst. The

odors are constant but vary in intensity according to weather conditions. Odor has not affected my meat
323 and grocery business. As Mayor I have received numerous complaints from residents of Lockport about
324 the Canal ever since I have been in office. I had some complaints not over two days ago. The odor is present both day and night. The canal, in 1940, is stagnant, no current, water lies there and there is more grease and oil-like and everything on the water. Water bubbles and breaks like a gas condition.

326 Condition of the canal around Lockport during the summer of 1940 is the same or just as bad as in the summer of 1939.

327 Lockport empties its sewage into the canal below
328 the power plant. Domestic water supply is taken from
329 deep wells. Our raw sewage goes into the canal and passes down through Joliet. We have one oil refinery located at Lockport, about a mile from downtown. At times we get odors from the Lockport refinery. It is a slightly disagreeable odor. The oil refinery have built what they call oil traps to catch any waste oil that gets away and the water from that runs down along a small stream which runs along the east side of the canal and empties into the canal south of the power house. That goes into Brandon Pool of course.

330 Before 1939 there were some offensive odors from this canal but the condition wasn't as bad then as it is at present.

The disposal from this refinery flows into the canal at least two miles below the City of Lockport. I was describing the condition of the canal as it was at Lockport.

331 These odors I mentioned were always present along the canal as far back as I can remember.

July 22, 1940

331 MRS. MARIE BUSH, Superintendent of grade
332 schools in Lockport for ten years. School located about
333 block from center of the business district, and eight
335 or nine blocks east of the Deep Waterway Canal. There was an offensive odor from the canal in April and May
337 of 1939. Makes me think of rotten eggs. Had to send children home in April and May 1939. They were sick
338 to their stomach and threw up at school. I couldn't tell you the exact number, but it was a good many.
339 Children remained out of school just a day or two.
341 Some had dysentery with it. Odor had no influence on my ability to sleep—I can always sleep. Odor this spring (1940) didn't seem to be quite as bad as the spring before (1939) because it was cooler, but in May when it got warm and the air was humid it was very
342 disagreeable and nauseating and we had a great deal of absence. It was intermittent according to the weather and the direction of the wind. Many were absent just
343 for the day with vomiting and dysentery. As many as ten and twelve absent in April and May 1940. The odor in 1939 was more intense than in prior years. We have always had an odor from that Canal but it was very much worse in 1939 and 1940.
344 I haven't made any complaints at any time to the
345 Mayor of Lockport or Attorney General's office. Ab-
351 sences in '38, '39 and '40 have been worse; increased in

'39 and '40. The odor described as similar to rotten eggs makes me think of hydrogen sulphide. I sup-
352 posed it came from the canal. The odors from the refinery are pleasant to what those Canal odors are. I can distinguish between the canal odor and the refinery odor.

354 It does not smell like there is hydrogen sulphide in the refinery odor. Ages of children in school average from six to fourteen and the absences extend through all grades. These children stay home for about a day and come back the next day—the nausea seems to have passed.

357 Children live one to four blocks away from the canal. They live on the west side of State Street and over near the canal.

July 22, 1940

360 THOMAS F. DONOVAN, lawyer and former Lieutenant Governor of Illinois. I am a resident of Joliet,
361 Illinois since 1905. I have lived within three blocks of the Sanitary Canal for 34 years. In the summer of 1939 there was a sort of nauseous odor differing in degree and in kind from any other odor I ever detected or noticed there before. There have been unpleasant odors from the old Des Plaines River in the past, but
362 now the odor seems to be a combination of unpleasant, disagreeable and nauseous. In 1939 the odors were more or less intermittent and more unpleasant in nighttime than in day. I have noticed such odors to some extent since about May 1, 1940. I would say they are more or less intermittent.

363 In 1939 I observed a coating, or a scum, that might be comparable to the scum caused by vegetation in a still or stagnant body of water out in a timber or on a prairie. I have no recollection of ever observing prior to the spring of '39, the conditions which anyone may observe there now. The condition is of recent origin.

364 By the term "nauseous" I would say that the effect, to illustrate, is something like what you would get if you would take a whiff of asafetida or something like
365 that. I have observed the odors during '39 and '40 up and down the channel from a distance of half a mile, growing in intensity as you approach the channel. I think these odors are the odors of gas that arises from an accumulation of human sewage not being diluted by a sufficient amount of water.

366 I believe that we who are here locally are becoming somewhat immune to this condition, and it is more noticeable to strangers and visitors. I don't think I have ever known of any illness traceable to this condition. A few times last year (1939) I had to leave my sleeping porch because of the odor and on last
367 Friday (July 19, 1940) I had to endure the heat of a closed room because of the naueous odors emerging from the direction of Brandon Pool.

The Sanitary District of Chicago is one of my clients and has been since December 1926.

368 I do not detect any odor in the court room now. The canal is located to the west and a slight breeze blowing from the southwest. This is about the hottest we have had so far this summer.

July 22, 1940

373 REV. CONSTANTINE BACH—I am a Catholic
374 priest, residing at 404 N. Hickory Street. I have lived at that address continuously for ten years. Off and
375 on you get a very strong odor from the river and again it isn't there. I noticed it especially during the last two years. I think it was considerably worse in 1939 than it was in 1938. I never paid much attention to how frequently it occurred. I would say it was the odor of the old-time outhouse. I suppose the
376 odor this year (1940) is about the same as 1939. The odor seems to be worse in the evenings. My church and residence is about two blocks from the waterway. I observed this odor in '39 and '40 in various parts of the city. I think it is worse down here at the southern end of the city.
377 It is just an offensive odor, that is all.

July 22, 1940

377 MARY S. WURTZ.
378 I have lived in Joliet for 30-odd years. I am principal of the McKinley Public School. There are six grades in that school. The average age of the sixth grade would be 12 to 13 years. I have been principal of that one school about 34 years.
379 Approximately 140 children attended that school in 1939 and 1940. My home is three-eights of a mile, perhaps, from the Waterway. The school at the closest point is I think at least 600 feet. In 1939 I noticed

odors at school—in the spring, summer and fall. It was very offensive and the children complained to the
380 teachers. They complained that they had to shut the windows in order to get the children's minds on their work, because they were restless on account of the odor that came in those windows. This school year (1940) wasn't quite so bad as it was last year (1939). During the warm weather last year it was almost continuous, and this year it has been more intermit-
381 tent. When I say "warm weather last year" I refer to June, July and August. That was after school was dismissed, but my home isn't so far from the Water-
382 way. Children have become suddenly sick with nausea, and there seemed to be no special explanation for it. The last of May or first of June this year (1940) I noticed there were several children who were quite
383 sick in school and had to be taken care of. The odor at the time I observed these symptoms of illness on the part of the children was noticeable and disagreeable. Not more than two or three children had to be taken out of their classes during a day.
384 That happened on more than one day. We had fewer experiences with nausea during the winter months when the odor wasn't bad. Children get sick any time of the year. The four other teachers at school complained about that odor in 1939. In the spring of 1940 I observed symptoms of illness on the p... of the children. They were nauseated and they were sick, and we sent them home—were kept home for a day
385 or so. In don't think there was more in 1940 than in 1939. About the same. The odor at the time the children were sick in 1940 was noticeable—it was bad.

I think the odor was worse in 1939 than it was in other prior years. 1940 is bad but 1939 was, if anything, worse.

386 At my home in 1939 the odor always seemed to be pretty bad at night and it has kept me awake at night because the smell was so bad.

388 The average age of the pupils that were sick would 389 be around 10 or 12. Girls, I think, more than boys, were more susceptible to the nausea.

July 22, 1940

390 HOWARD SONTAG, 111 7th Street, Lockport, Illinois. I work at the Texas Oil Refinery at Lockport. I have lived in Lockport continuously for about 35 years. I am a former Mayor of Lockport, 1931 through to 1935. The condition of the waterway and its effects as I observed them during 1939 were, I think, 391 terrible, especially through the warm months, from April until the latter part of September and into October. As weather got a little colder the conditions cleared up. The odor was very bad, especially when we got a west or a southwest wind. The odor was intermittent in 1939. As I observed it there was a lot 392 of sludge on the surface of the waterway. It is a tarry substance—a sewage residue. These odors were observed two miles from town when the wind was blowing. I wouldn't say they actually made people sick but it wasn't very pleasant to breathe. You wouldn't sleep when the odor was coming in good. The only way you could sleep was by closing the

393 windows. I didn't personally make any complaints about the condition there. I got a lot of them though. I had nausea in 1939, sometimes twice a week, sometimes for over a month.

395 The odors in 1940 haven't been as bad because we haven't had the warm weather, but the last couple of days they have been terrible. I think the odors in 1939 were worse than they were in 1938. The last two days they are worse than they were in 1939. You don't detect anything right now in the court room but I bet up in Lockport you can detect it. We are only six
396 or seven hundred feet from it here. My health is good except for a skin disease. I want to get to a doctor and find out what it is.

397 In my work at the Texas Company I treat gasoline and kerosene.

Some odors along the canal have been there as long as I can remember. I got a lot of complaints as Mayor during 1931 to 1935 but there wasn't anything to be done about it at that time.

398 The liquid from the refineries that runs in a small channel paralleling the canal and then enters the canal some distance below is water from the traps. There would be a little oil on there. They don't let much get away. The odor from the refinery is detected at
399 Lockport at times. When the wind is from the northwest you get this oil odor right down town in Lockport. There is considerable difference between the two odors. I can absolutely detect one from the other.

400 I probably did have nausea while I was Mayor. It came more often in the hot weather than in the cold weather.

July 22, 1940

401 CLARICE BLATCHLEY. I live here in Joliet at 417 Grover Street. I am employed as a teacher at the Mc-
402 Kinley School. Began teaching there in September 1938. Miss Wurtz who testified is my principal. I have lived in Joliet all my life. My residence on Grover Street is approximately a mile from the waterway.

In 1939 it seems to me we had a great deal more noticeable odor than we had prior to that time. We had very few hot days in May and September 1939, but those days it was terrific.

403 I was at school when I made those observations. I sent a child home. She was ill and there were several of them that were quite upset. During that hot weather the odor was so bad that we had to close the windows, but there was this one child that just couldn't stand it, and we had to send her home. The odor at that time was very bad.

404 There are many flies in my room that certainly must have come from the terrible green viscous looking color that was on that body of water that lay there stagnant. I bear a scar on my foot that I received from a fly infection. Dr. Frederick treated me for it. I had shots for tetanus, and it must have been from that bed of water that these flies came from. The odor was terrible. I have never smelled anything like it and it is something that I couldn't describe.

405 The body of the water was practically still. It was covered with masses similar to cakes of ice floating down a river, only instead of being the lovely color

of ice it was a terrible green. I have received complaints about the condition from children, from their mothers and from my school associates. The complaints
406 were about the odors. I would say that the aroma was very bad on the hot days we have had this year of 1940. When during the school year we go outside on the playground or recess, sometimes it is positively unbearable. That was my experience this past spring. I have observed the odor at other points in and around the community. At my home which is approximately a mile away, at night, of course, all windows are open and it is very unpleasant.

407 I noticed that the odors in 1939 were more intense than in 1938. It seems to me that this year 1940 is getting worse and worse as time goes on. It is a great deal more noticeable when it is hot and when it is quite humid. When it is cool we don't pay so much attention to it.

408 I have no official duties connected with the Illinois Waterway. I know of no reason why complaints regarding the waterway should come to me personally.

409 I do not detect any odors here in the courtroom from the waterway now particularly.

411 I don't remember the summers from '36 through '38. I really think I can say that it was all right; that it wasn't so noticeable to me that it was obnoxious.

412 I testified to sending one little girl home in May of
413 '39. I beg your pardon, sir. It was this year—I can't remember whether it was April or May. It was this last spring.

414 This little girl I sent home is apparently well. I don't remember whether she stayed home longer than

a day or not. I have seen this year (1940) that green-looking stuff I spoke of. The time I noticed it was last fall more than in the springtime.

415 Go out the Channahon Road, turn to your left at the Brandon Locks, and if you will walk down where the dam is you will see all of this mess clogged up. The last time I was there I believe was in April of this year (1940).

416 I have lost no time from work because of the bad odor. I should have but I didn't.

I have a mark on my foot where I was infected by flies.

418 When I stated that I had lost no time from work but should have, I meant I had a foot that was so enlarged that I was not able to really stand on it.

July 22, 1940

420 BRUCE D. CHEADLE. I reside at 120 East 6th Street, Lockport, Illinois. With exception of one year I have lived there all my life. I am employed in the Chicago City School System. I am secretary of the Chamber of Commerce in Lockport, an incorporated not-for-profit institution. Also I am secretary of an organization representing the valley communities
421 from Joliet to Summit called the Des Plaines Valley Improvement Association. The municipalities from
422 Joliet to Argo-Summit are members. After the reduction in flow in January 1939 or thereabouts there was
423 a noticeable increase in the odor and the scum of the canal. Joliet and Lockport have a situation that is

not existent at other communities north of Lockport. They both have pools where the flow of water is slower than through the main channel north of Lockport. At Lockport we have a pool above the lock from which we catch the smell, because the prevailing winds in this territory are southwest. The smell is comparable to what you get if you lift cover from a manhole in the sanitary sewer system of Joliet. My home
424 is about 1000 to 1200 feet due east of the canal. During summer of 1939 after or during a rain storm this odor is particularly noticeable and my wife and I have been driven off our sleeping porch. It has not occurred this year (1940) yet. I had no such similar experience prior to 1939 although this canal has been a source of complaint in the valley prior to 1939. We have always objected to it being a cesspool for the City of Chicago, or any other territory. There has been an odor there but it has been severe since 1939, more intense since January 1939.

425 In 1940 the weather hasn't been so hot that we had to sleep on the porch and the odor hasn't been so prevalent during the cool weather. I never noticed during the winter months any odor that would trouble us to speak of. The odors arising from the oil refinery up there at Lockport are occasionally blown over Lockport and sometimes they are strong, but they are easily identifiable from the canal odors.

433 In my estimation this year (1940) has not been as bad as last year (1939), but when these barges pass up and down the canal and several of them get in a string, the odor and the gases from the sewage or other

fecal matter in the canal becomes worse if it is stirred up.

434 I have lived at Lockport approximately 43 years and during all the time I have observed the canal there
435 has always been some odor. To the best of my knowledge the canal has always received the untreated sewage of the Sanitary District of Chicago. There have always been complaints about it for years back, urging that something be done to clean up that situation, but the complaints have been more urgent and more multiplied since 1939. To my knowledge none of the communities members of the Des Plaines Valley Im-
437 provement Association treats its own sewage. None of these communities takes its domestic water supply from the Illinois Waterway. They get it from deep wells, except Argo, which gets its water from the City of Chicago.

438 I do not now detect any odor in the court room.

439 We slept on our porch last night at Lockport. I didn't notice any odor.

July 22, 1940

442 DR. LOUIS J. FREDERICK, I live at 222 East Clinton Street, Joliet, Illinois. I have lived here for many,
443 many years, approximately thirty-five. I am and have been Health Commissioner of the City of Joliet for a year and a half. I am acquainted with the conditions
444 surrounding the Deep Waterway Canal to the extent of the number of complaints that I have received. I have observed the canal myself on several occasions.

445 In 1939 the surface of the canal was covered with considerable scum. The odor in 1939 was very much more offensive in 1939 than in previous years. The number of complaints I received as Health Commis-
446 sioner went into the hundreds. People would call up
447 and say: "Why don't you do something about this stench in the canal? We can't sleep, we can't eat and can't work. We are suffering from nausea", and some of them went so far as to say they vomit. Many of them were nauseous and in summer all of them complained of the insomnia due to the odor.

450 These hundreds of complaints to which I referred were received in 1939 during the hot season—June, July and August, and this year (1940) during June and July. They were received from people residing not very far from the banks of the canal—I would say within a radius of a mile from the canal.

451 The origin of this odor that we are speaking of is putrefaction of material in the canal. The scum that forms in the canal is loaded with bacilli that we call colon bacilli, the odor of which you will probably never appreciate unless you smell it and if you smell it once you will never forget it. It is one of the most deadly odors of any of the germs that we have in the human body, the colon bacilli. The odor is particularly obnoxious in the hot weather because the gases rise from this material and it permeates the air.

452 I would say that this odor is due to hydrogen sulphide, otherwise it is a lack of oxygen. I, myself, noticed this odor throughout the summer of 1939. I noticed it every time I go from one side of the canal to the other. The farthest distance from the canal that

I noticed the odor during 1939 was probably within a block, crossing the bridges.

453 My home is about four blocks from the waterway. In going back and forth my attention would not be called to the odor until I got up within a couple of blocks of the canal, but I have noticed it in my home and that is about four blocks from the canal.

454 We get the odor from the north end of the City of Joliet to the south end of the City of Joliet and we get it within a mile on either side, east and west. Some of the local physicians have told me that their patients complained. I have never personally observed any evidence of temporary illness resulting from the odor.

455 In my opinion if this odor continuer we are faced with an epidemic. The fecal matter, the germs, flies, mosquitoes, will light on this, on the walls, on the sides of this canal. You will see it covered with scum. Flies and mosquitoes will light on this and carry away—they have been known to carry germs from that, and

456 that might mean dysentery or a typhoid fever epidemic.

457 The two most serious diseases that might be borne by the insects would be dysentery and typhoid fever, but it might carry with it any intestinal disease, catarrh, colitis and diarrhea.

458 The most common carriers are flies and they do carry germs and mosquitoes carry them. This material, this scum on the water dries. The flies light on it, and it is carried, wafted away by the winds, where, no one knows how far they carry it, but it has been known to be carried for miles.

459 The stench, aside from the germs, is nerve-racking. It may produce nausea, loss of sleep and loss of appetite, and the majority of the people in Joliet have to work for a living and if they cannot get their rest at night, and if they cannot eat, it brings on a condition which may lead to other more serious conditions; in other words, lowering of the vitality.

460 A more serious hazard is presented now because
461 we did not have this condition in 1939. The odor I have observed in 1939 and at the present time could be nauseating to anybody with a sense of smell. I
462 am not here to say that you don't get nausea and vomiting from other conditions, but I do know that a continuance of this odor produces or brings on a condition of nausea.

The gases that arise from this odor may set up an irritation of the mucous membrane of the nose and throat, setting up rhinitis, sinitis. These germs don't grow on healthy tissue. You have to have an irritation, heat and moisture for their propagation. You have your start with rhinitis—an irritation and an inflammation of the nose. Germs come along and light there and they go out to the sinus. They may be carried through the eustachian tube to the ear, and they
463 may go down the throat causing tonsilitis. Streptococcus germs come along about that time and you get a streptococcus infection of the throat.

If a bad smell is surrounding you your nervous system won't permit you to sleep because you will be restless.

464 Health conditions in Joliet are very good. I wouldn't say that they were any worse in 1939 than in 1938,
465 speaking generally. The only increase in diseases with

which my department is concerned was we have had several cases that contracted typhoid at Manteno, men that were working there, and they came back home feeling sick and after they arrived here, the doctors of course said typhoid fever. That had no connection with the water though. Otherwise we have had no increase in communicable diseases in Joliet in 1939 and 1940. The only difference in the canal is the odor, that is all.

July 22, 1940

471 DR. G. J. WILCOX. I am licensed and have been
472 practicing medicine in Illinois for 28 years. My office is at 108 Scott Street five or six blocks from the Waterway. I am generally familiar with the condition of the waterway in 1939. The surface of it has always been quite heavy with scum, and particularly where
473 the water is more quiet, referring to Brandon Pool along in there where it is wide and the water isn't active. The locks were installed, I guess, seven or eight years ago. I think it was something like 1933. I think that the odor that emanated from this condition in 1939 was terrible. It is an odor which I think is supposed to be created by hydrogen sulphide. This putrefacted material forms a hydrogen sulphide and ethyl-
474 ene gas, and ethylene gas is practically odorless, but hydrogen sulphide has a very commonly called rotton odor, an odor of decomposition. It was very much worse the closer you got to the Waterway. I think the scum must be loaded with bacilli and germs, because

that is the common occurrence of human excreta in any stream that is polluted as badly as this stream is. I think you are liable to find particularly colon bacillus,
475 which is more common in bowel excreta, and streptococcus. Flies and mosquitoes are the usual carriers of such bacilli germs. The germs I think could be blown or carried on the breeze if they happened to be on some dry surface where the bugs were pretty prevalent. They could be carried perhaps two or three miles
476 and still remain virile. I didn't keep track of the odor by months in 1939. I noticed it was much worse during the hot weather. In my opinion the odor is worse since the diversion has been cut. I can't say that it is any worse this year (1940). We haven't had an unusual amount of hot weather. I think the depth of the scum is worse, if anything, this spring and summer. I am satisfied from my observation of it that it still contains a putrid matter in the process of decomposition, and that this is the source of the odor that you smell.

477 I think it is only reasonable to presume that that will seriously upset the health of people that are asked to breathe in odors of that kind continually. It will cause symptoms of certain kinds, perhaps, vomiting,
478 nausea, perhaps it would cause loss of sleep, loss of appetite. I think there are a number of diseases that this condition could be responsible for, and that there is adequate cause for an epidemic in the community. If some of that water or drainings should get into wells it certainly could cause typhoid or different forms of enteritis or bowel infections. I think flies, mosqui-

toes, something of that kind, could easily cause sinus infections or eye infections or ear infections.

479 Those working on the waterway might have a scratch or an open wound of some kind which might develop into a very serious infection. I consider the condition of this Waterway at the present time a threat or a hazard to the health of the people of this community for the reasons I have just given.

480 The odors could reasonably be the cause of the delay in recovery of patients in St. Joseph's Hospital, located within one street of the canal. The unpleasant odors might cause trouble in sleeping, might affect upset people from the standpoint of the nervous system.

481 I do not know of anybody of my own personal experience that has been made sick by this water.

487 I could not enumerate for you how many people I have treated during the calendar year 1939 for any of the infections that I have named.

488 I have treated many in the last year for infection of the hand or leg. I do quite a bit of industrial work and a good many of those cases. I have treated in the last year (1939) for inflammation of the mucous membrane of the nose and throat, for streptococcus infections. I have known of colitis cases here, and of dys-
489 entery and other infections of the intestinal tract, but I couldn't say that the Waterway was a contributing
490 cause. In other words, I don't know where they got the infection. My records would not indicate that Joliet had any more people with these illnesses than you would find in most Illinois communities.

July 22, 1940

496 DR. H. W. WOODRUFF. I reside in Joliet, Illinois. I am a practicing eye, ear, nose and throat doctor. I have practiced in this state about 47 years. I am familiar with the physical appearance and the odor emanating from this canal.

497 I go over it a good many times a day. The surface never looked like a mountain stream of water going through here. It is a dark, cloudy, muddy-looking stream of water. Before the diversion was reduced in 1939 it looked like Lake Michigan water coming through here. After the reduction in the flow of water there was considerably more odor from the stream.

498 The odor we speak of is indescribable. It is a difficult think to describe an odor of that sort. With this more concentrated sewage in there you get more like the odor of a sewer.

499 Since the flow was reduced there is a very definite increase in the intensity of the odor. You are more apt to get the odor on the west side and north side. Our prevailing winds are from the southwest. In my opinion the waterway in its present state is a health
500 menace to this community. The more concentrated the sewage the more of a health menace it is. Most diseases are caused by microorganisms, infections; and the more of those microorganisms you have, the more of a menace it is. Local diseases like infections of the skin or the ears or the eye could be caused by such a polluted stream as the deep waterway canal in its present condition.

501 They would be caused by certain organisms, sta-

phylococci, streptococci, inflammation of the eye, the inside of the lids, conjunctivitis on the lids' margins themselves due to water getting into the eyes and on
502 the skin. If the sewage and water gets into wells it would be a serious menace. I don't think inhalation of the odor itself would cause the irritation, but possibly the sulphurated hydrogen or any concentrated irritating gas could do that. There is a gas given off by that canal but I don't know what it is. I don't know from my own knowledge that the canal water contains the colon bacilli germ.

503 I think very positively and definitely about the condition of this canal being inimical and a threat to the health of the people of this community, and yet I can't prove it definitely by specific cases. I can't put my finger on a case and say that was due to this.

505 The only increase in cases under my observation within the last year or two is eye infections from swimming pools.

July 22, 1940

506 HERMAN C. GRASSLE. I reside at 209 Western Avenue, Joliet. I am in the motor truck business. I live just on the other side of the wall of the canal, about two and one-half miles north of Brandon Pool locks.

507 I have lived in Joliet 54 years. I have noticed a change in the condition of the canal last year. The river is dirty. I can sit on our side veranda and look over in the water and the water would be bubbling

continually and great gobs of sludge would come up from the bottom, just kind of an explosion, and you could see that day after day. It started in about two months ago. We had some warm weather and that time it started to do the same thing .

508 The odor was terrible. It got real bad in 1939 just when it started getting warm. Last summer (1939) it was nothing for us to get up two- three o'clock in the morning, close the windows, and after doing this several times my wife thought of spraying perfume around on the bed clothes thinking we could sleep. The effect of the odor on me is that I walk away from the table and leave the food there.

509 It is just obnoxious, putrid. Last summer (1939) July 5th I came back from Des Moines, Iowa and I recognized the odor about two miles west of Joliet, and frequently I have noticed the odor I would say, 12 blocks east of the river.

510 In the 54 years that I have lived on this bank I never noticed any summers that approached the last one (1939). We had some warm weather in May (1940) and we had about three days that it was really
511 bad. Last Friday or Saturday (July 19 or 20, 1940)—I don't remember which it was—it was bad. In the daytime it wasn't. Last night (Sunday, July 21, 1940) was all right. Today on my way home to lunch there was a little odor but nothing like it is generally. When the atmosphere is heavy, or when it rains it is really
512 terrible. My health is fair.

I was affected by this odor in 1939 about 12 or 13, probably 14 different days. The odor isn't constant. It would be that way for a day and maybe gone for

513 a day or two and finally it comes back. The longest the odor has been constant is probably two days.

516 I am five foot six tall, weigh 173 and am 54 years old.

July 22, 1940

516 RAYMOND SHEA. I live in Joliet but not in the in-
517 corporated limits. I am President of the Central Trade and Labor Council. It represents about 10,000 laboring men in this community. We hold meetings in the Chottes Hall at the corner of Joliet and Jefferson Streets, just a little over a block from the canal. Last meeting was held July 15, 1940. Possibly 125 people were present.

518 Meeting room is approximately 40x60 feet. I don't know what the temperature was on this night but it was warm because all the delegates had their coats off. It wasn't uncomfortable with your coat off.

519 I have observed and smelled the odor from the deep waterway canal in the past. The odor was very noticeable at the meeting last Monday (July 15, 1940) and at meetings prior to that especially in the hot weather last year (1939). Last Monday the odor was very rank up there. We closed the windows facing the south because it seemed that the smell was coming in from the canal through the south windows. We relieved the odor in the hall. When the windows were
520 open the stench was very obnoxious. I live about two and a quarter miles east of the waterway. I have noticed the odor at my home. I think the odor was far more offensive last summer than in those prior to

that time. We never had the complaints in our meeting hall up to last summer when they started.

July 22, 1940

521 DR. LEWIS W. WOODRUFF. I am a physician at the Woodruff Clinic. I have been practicing for twelve years. I specialize in internal medicine. I have had occasion to observe the appearance of the canal during 1939.

522 During certain periods there is a stagnation and an accumulation of solid material on the surface of the canal. These periods were during the hot and dry season. It is at that time the odor from that is very offensive. I think the odor during the summer of 1939 was more offensive than in prior years. I have noticed the odor on some days this year (1940). I would de-
523 scribe the odor as of a fecal character. A stench would be a good word. I think it made me uncomfortable during the time it was bad. I consider the canal in its present condition a menace to the health of the community of Joliet. To the patients it is perhaps indirectly a menace because the chronically ill would be affected by very bad odor from the canal. It would
524 interfere with their recovery I believe. There is a potential danger from the dilution if there is any leak in the canal. Highly polluted water would cause contamination of surrounding land and wells. The effect of the odor upon the human organism may cause nausea, occasional vomiting; it causes loss of appetite; it may disturb rest of people who are ill. As long as the

odor continues that is a temporary result. I do not recall the longest period of time in 1939 the odor hung on.

525 This resulting nausea or loss of appetite remains just as long as the odor is present. I think the inhalation of that odor, would postpone recovery in chronically ill patients, probably such as heart patients, because they are not able to eat normally or rest properly. I have observed only one case that I can think of specifically that has had that experience. The patient stated that the odor from the canal interferes with her sleep and caused nausea and vomiting, loss of appetite.

526 This patient has chronic heart disease. She is still living. She has been in the hospital for four or five years. She probably grows worse very gradually due to the heart condition.

July 22, 1940

526 DR. ROBERT W. LENNON.

527 I reside at 900 Western Avenue in Joliet. My office is located in the Morris Building on Chicago Street in the downtown area. I have observed the waterway canal during 1939. The condition isn't present at all times, but many people seem to think it occurs right after a rain. My observations have been that the canal and waterway have been worse following a dry spell in which there has been a decreased amount of water

528 in the flow-way as a result of not having any drainage from the rains. At this time you can see the de-

bris and various other materials floating down the canal. I have been practicing 12 years and specialize in eye, ear, nose and throat.

My observation as to the effect of the odor emanating from the canal on the human organism would be rather limited because of my specialty but I have noted a definite increase in the last year in the number of sinus cases and that I have observed in the warm months—July, August and September. Ordinarily during those months we had little sinus trouble in this community, and little sinus trouble is observed in other communities of the Great Lakes district. We have a great deal of warmness and heat and sinus conditions, as a rule do not occur under that type of tem-
529 perature. I have also noticed that chronic cases I have been observing from year to year have been definitely worse, and I hadn't thought of anything else to attribute that to. These people do complain of the odor when the odor is present.

In my opinion there is no question about the odor being a factor in causing this increase in sinus condition. The place isn't different, the community is the same; the people haven't changed; the mean temperature is about the same, the humidity is approximately the same. The only thing different that I can detect is the odor that is coming from our canal. It has been proven experimentally and actually that such a gaseous odor causes an irritation of the sinus passages. From the strict chemical standpoint I am not extremely familiar with that odor. Of course, the decomposition of the fecal matter gives off a sulphurated iron. Fur-
530 ther than that I couldn't describe it. Such sulphurated

iron could certainly irritate the sinus channels if you inhale it. As to the inhalation of this odor deterring recovery of patients in cases of other illnesses, most of those things work from the standpoint of the nervous system and the element of mental upset that can be caused by a stench is considerable. I have had people come in my office complaining directly of the odor and stating that it bothered their nose and couldn't I do something about it. So far the condition this year (1940) hasn't been so bad as 1939, but it depends entirely on the rainfall conditions, I think.

531 I am speaking about the summer of 1939 that I noticed this increase in sinus conditions. I am not speaking about this year (1940) because the odor was much worse in that canal last year than it has been this year to date. I said that experimentally it has been shown that obnoxious gases similar to hydrogen sul-
532 phide in animals has shown irritation in the mucous membranes of the nose.

534 I am unable to answer the question what percentage or concentration of hydrogen sulphide must be present to cause irritation of the sinus.

535 The average length of hospitalization in my specialty is about a day and a half. That would be the general average and Joliet is approximately the same as average.

538 Anything that will irritate the mucous membranes of the nose will aggravate sinus conditions, regardless of whether it is hydrogen sulphide or what it is.

Tuesday, July 23, 1940

547 DR. CHARLES R. CURTISS. Office in the Barber
548 Building and resides at 954 Glenwood Ave., Joliet, Ill.
I have been in general practice in Joliet for 40 years.
I serve as physician for the Ohio River Company who
operate barges on the canal, and treat employes of
549 that company. During 1939 I had occasion to treat men
employed on these barges. Have to protect them against
the risk of infection of wounds received on the wa-
terway. I have seen lockjaw, gas and strep from in-
fection of wounds received on the waterway. The
550 danger of infection exists because the river is loaded
with infectious germs. Practically all the river men,
if they have wounds, have digestive disturbances and
552 are nervous. They can't sleep—their sheets smell vi-
cious, ugly odors. The positive result of direct con-
tact of this water to an open sore would bring infec-
tion. I have observed lockjaw, gas considerably and
the different strains of streptococcus infections. Pro-
phylactic injections for lockjaw and gas are given as
553 emergency treatments before an infection sets in. As
to skin infections from contact with this water, we
have a great many cases of impetigo along the water-
554 way—it has been increasing each year. Men who work
on the river get it and other forms of dermatitis, and
children living in Joliet, especially along Bluff Street
have a large percent of impetigo. It is the ordinary
pus infection in the skin, the same pus that makes an
555 abscess. The more common way of transmitting ba-
cilli to the community would probably be insect car-
riers—flies and the mosquito. The types of diseases

that would be transmitted are malaria, possibly typhoid—intestinal infections. Patients in hospitals get hysterical from this awful odor—they can't sleep. The men on the river can't. The odor would make the recovery or convalescence from other illnesses more difficult. It might be serious, but it is very disgusting and upsets their nerve balance.

557 The canal since it was opened in 1900 has always been polluted with raw sewage. The danger of in-
559 fection by reason of cuts has probably always been present, even prior to January 1939. Since the canal walls were put up in 1933 there has been an increase
560 in impetigo. With increase in traffic on the waterway and the Ohio River Company having more employees, there is more likelihood that the percentage of my cases is also greater. Streptococcus throat infec-
561 tion has been on the increase in the last year. I don't know what the percentage is. The majority of men don't report it. The three cases for the first six months of 1940 shown by the City of Joliet reports would not be a drop in the bucket. Strep throat is a reportable disease if it is associated with influenza, but by itself or a streptococcus wound, I never report it. Prior to 1939 they had quite a few deaths of strep throat in Joliet—now they seem to be able to control
562 it somewhat with sulphanilmide. So far as I know there were no deaths in 1939. I do not know of any reported in this area the first six months of 1940. There would have been an avalanche of them if we hadn't had the means of preventing it. We had a large epidemic of it (strep throat) last winter (1939). I am sure, because I did. We have more of them when

the flu starts beginning in October and going on to
563 March-April. I haven't heard of any typhoid cases being reported in Joliet the first six months of 1940 —they have been free from it. We have had malaria. It is not a reportable disease. I had three cases last year (1939). I haven't had any the first six months of 1940. We have had no deaths in 1939 or none in
564 first six months of 1940. Insect carriers would get bacilli from walls, on the scum that lines the walls of
565 the canal. I consider the scum on the walls lining the canal contain dangerous bacilli. I have never made
568 a test and examined it. It would be difficult to mathematically give an estimate on how many of the cases that have come to me have been compelled to be absent from work. Had quite a few of them off last winter (1939). It would average a few days to maybe ten.
569 That applies to infections, flu epidemics, streps and other things that they had, and stomach cases. I had one patient I had to send away twice to get him out of the atmosphere. I think he was gone three weeks. That was a month or six weeks ago—just as spring broke. I figured it was a nervous reaction because I
570 thoroughly x-rayed him and found nothing wrong. The giving of anti-tetanus injections is a routine prac-
571 tice if you have any fear—if we have any doubt about it, we give it. I have seen tetanus come from wading in the DuPage River. In injury cases which were
575 given preventive treatments I never had an infection.
578 In cases where there has been an infection, my treatment cured all but one in 1933. We didn't have as many
579 streptococcus infections in 1938 as in 1939. Last winter (1939) was the worst by far. That increase was

caused by the strains of streptococcus, wherever they came from I don't know. I wouldn't say the water did it.
581 I just observed it as a fact. I had one case that had to quit—a cook—going into panic with that odor. The fellow I sent away was a pilot. Got so he was afraid to take responsibility of the load and had to send him away.
587 During the forty years I have been practicing in Joliet I have had a great many infection cases—impetigo and
588 and others—before 1939 as well as after. It is a fact that impetigo in children could be caused by scatching them-
589 selves with dirty fingernails. The odors from the waterway were terrible last year (1939). Conditions up to now are not as bad this year (1940) as last year. Odor
590 in winter is not near so noticeable as in summer. Organic putrefaction takes place much more rapidly in heat. Throat conditions in winter would be less likely
591 attributable to the canal than throat conditions in summer would be. If a person had the start of a cold, of course he is prepared for strep infection and if it is prevalent he is likely to get it. I detect no odor from the canal in the courtroom today (July 23, 1940).

596 LEO COSTELLO. In grocery business at 353 So. Joliet Street, Joliet, Illinois and reside at same address—about two blocks from the canal. I noticed plenty the
597 odor given off by the canal in 1939. Previous to that time there was a little odor but it was never so obnoxious or prevalent as it was in 1939. During 1939 it became so we would't stay in our home during the evening. Would usually drive out in the country to get away from the odor. Previous to that time we never had occasion to do those things. Odor disturbs the

598 appetites of myself and family. At times every one of
my family was disturbed with throat ailments. Throat
condition usually occurred the latter part of spring—
599 during the summer months. In spring of 1939 the
weather was fairly nice and there was no reason why
they should have sore throats and still they had sore
throat. Usually in spells members of family would go
down with it. Every time any member was down I
600 would call the doctor. I called the doctor eight or ten
times for throat ailments in spring of 1939. My family
and I suffered from nausea quite regularly and that
came at the same time I smelled the odor from the ca-
nal. I talked to doctor about that condition and the doc-
601 tor prescribed a course of treatment. Sleeping was af-
602 fected by the odor. Entire family is disturbed when
that condition arises. There isn't much I could do
about it; usaully drove out and stayed out as late as I
possibly could. Drove away practically every night
603 last summer (1939) to get away from the odor. Some-
times the odor last summer (1939) was real bad two or
three nights of the week and the balance of the week
was where you could get by on it. If all the time this
condition affected me last summer was aggregated I
would say it was about three months. Conditions this
year (1940) haven't really disturbed us. When I went
in store this morning (July 23, 1940) there was a ter-
rible odor and I knew it came from gases. Couldn't
smell it on the outside but store seemed to have filled up
with it and earlier in the spring I thought it was quite
prevalent. The stench has affected my mode of living
604 so that I am placing my business for sale. Intend to
move away from the locality.

I have very fine grocery business; been there for 16 years. There has been a little odor from this waterway in years previous to last year (1939) but it didn't disturb us. It is true that I have had only one bad year in all sixteen years but I expect the odors are going to continue and I don't want to put up with it. I am 40 years old, 5'7" or 7½" tall and weigh 185.

THOMAS CALAMARIS. In grocery and bakery business on east side of Bluff Street next to the river. I live at 203 Reid Street, about 12 blocks from Bluff Street, Joliet, Illinois. I have lived in Joliet for 27 years. I never noticed the condition of the canal to amount to anything before 1939. In 1939 it was unbearable—couldn't stand it. Had to keep doors closed and still couldn't keep it out. It was just like gas from sewer. I was bothered at home only in 1939. It was the same thing. Didn't believe it could reach us 12 blocks. This year (1940) they had only a light dose—very small. A couple of times in May and June but it was only noticeable. In 1939 it disturbed my sleep at the house but not this year yet.
July 23, 1940

MRS. ROBERT W. MARTIN. Reside at 705 Buell Street, Joliet, Ill., about a mile west of the deep waterway. Has lived in Joliet 34 years. In 1939 we on the west side observed many times an obnoxious odor—before that time we never had. In my own case there were many nights when I couldn't sleep because of the terrific odor, and many times it would be nauseating to me. I never noticed that effect upon me prior to

612 1939. My husband is a very sound sleeper and did not notice it particularly. This year (1940) it has not been nearly as bad as last year.

612 JOSEPH AVON. Reside at 600 South Des Plaines
613 St., Joliet, Ill., a quarter of a mile away from the canal. I have lived in Joliet since 1892. I did find conditions at the canal kind of strong in years before but 1939 was
614 the worst. The odor had plenty of effect on me. Every night the wind blows from southwest or northwest to
615 the east I can't sleep. Also affected my wife and daughters. Wife has been under care of Dr. Thomas Wagner for about twenty years. She has been sick for a long while. Since 1939 she got worse, couldn't sleep—couldn't eat—lost her appetite—lost her eyesight. Tried to shut the windows at night but couldn't stand the heat—had to get up all night and walk around. This year (1940) the odor wasn't so bad on account of cold weather but now it starts.

617 STEPHEN J. HEINZEL, I am a city fireman. I live at 510 Sherman Street, Joliet, Ill. Has lived in Joliet 27 years. On May 13, 1939 was over on South Bluff Street
618 going through our regular firemen spring drills and one of the men noticed a person in the water—an attempted suicide. I jumped in and rescued him—went into the river 75, 85 feet and was in t'e river about
619 seven or eight minutes. Name of man was Vernon Earhardt. After pulling this man out I went back to engine house and notified a physician to come. While he was coming I took a shower. Called Dr. Raymond Kennedy, When he got there he washed my eyes and ears--with

what I do not know. I received a shot—I believe they
620 call it a gas tetanus. When I jumped in I received a bruise on my right ankle. Dr. Kennedy treated the bruise at the engine house and I had to go back to him at least two months. An infection set in the bruise and
621 lasted about two months. My health is good, weigh about 190 pounds and height is 5'8-¾".

622 ADAM CHRISTMANN, I am employed as lockman
623 at Brandon Road on deep waterway for about seven years. Live at 33 Argyle Street, Joliet, Ill. Conditions on this canal first four or five years wasn't so bad, but since they cut the flow we can notice it. Water in locks is almost black as ink. Carp and turtles used to live in
624 the locks but since they cut the flow, carp even died. The odor in 1939 was quite a bit worse than it had been in the past. It never used to smell until along about May. When they cut the flow it started smelling February, March. I am pretty well used to the odor but in 1939 it make me a little sick. About June 11th or 12th, 1940 I couldn't eat my lunch for two days. The sludge and scum on the locks smelled and it turned my stomach. Conditions this year (1940) are about the same as in 1939. If hot weather keeps up it will
625 probably be worse than it is now. There was a whole lot more accumulation of scum on the canal last year (1939) than there had been in years past. Average thickness of scum looks like anywhere from two to six inches right above dam at Brandon Pool. They had scum there in the past but scum was its worst in summer of 1939.

Today there isn't so much scum and sludge collected

626 but the odor is just as strong. I haven't missed any lunches since June 11th and 12th, 1940. I feel sickly
627 but can still eat. My health is pretty fair.

In the years before 1939 the odor ended one or two
628 weeks after a heavy frost—along about November. It ended in November last year (1939). I have had no
629 sick leave in last five or seven years. There is a difference in the odor of the water when the locks are being filled or emptied. When the water begins churning and filling the lock the odor is stronger because it turns up that scum. There is a continuous smell and odor down there (Brandon Locks) anyway, but when you fill the
630 locks it smells more. I notice it more at night because every night just about sunset they raise some gates down there—some nights two gates—some nights three gates and sometimes four gates. As soon as it gets daylight in the morning they close the gates. The Sanitary District up there increases the flow—they make power for Chicago and with the increase in flow we raise the gates to keep the pool at same level. I weigh about 180 lbs. am 5' 10" tall and 49 years old. They
632 (The Sanitary District) increase the flow for the winter months. In the winter months it gets dark at five o'clock. In the morning the flow isn't cut until around seven o'clock when it is daylight. In the summertime the flow isn't increased until nine in the evening and at four o'clock in the morning the gates are closed be-
633 cause they don't need any more light. They have to keep pool at level of 17.9 feet. The Sanitary District call them up from Lockport when they increase flow so they can go out and operate the gates in time.

634 MRS. VINA POOLE, I reside at 814 Kammerman Ave., Joliet, Ill., about a mile and a half from canal. I
635 have lived in Joliet 26 years. In 1939 the odors from the canal were considerably worse than they ever had been before. The effect upon me was loss of appetite, loss of sleep, nauseating. Affected some of the other members of the family. They have difficulty in sleeping
636 on nights when the odor comes over from the canal. I am not affected with nausea much but my husband complains quite a little bit from the odor. I believe conditions this year (1940) are not quite as bad as they
637 were in 1939 because of the cool weather. I don't remember conditions in 1938. I know there always has been some odor from the canal. I thought it was terrible all during last year (1939). My appetite is pretty
639 good. Health is good. I diet only when the waterway smell comes.

Tuesday, July 23, 1940

640 PETER CATTANEO, I reside at 663 South Water Street, Joliet, Ill., about 2½ blocks from the waterway.
641 Have lived there for twenty years. Condition of deep waterway canal last summer (1939) and this summer (1940) is awful bad. I can't sleep at night on account of smell. Lost about ten pounds last summer and this summer because I can get no rest during the night. Since 1939 I know I went down more than 10 pounds and this summer have gone down 7 pounds already. Before 1939 had a little difficulty sleeping but not so much. Odor in 1939 was a lot worse than it was be-

fore that. It had no other effect on me except loss of ap-
642 petite and loss of sleep. Bothers my wife and two daughters too. Youngest girl has a headache most of the
643 time on account of that smell. She did not have headaches before 1939. So far this year (1940) on account of the cool weather conditions really wasn't so bad, but for last three or four weeks it was awful bad. Noticed the odor at my home last night (July 22, 1940).
644 Ten pounds weight lost in 1939 was gained back in
645 wintertime when it is cool weather. Weigh now 155 pounds. Am 49 years old and 5' 10" tall. Weighed 162 in 1938 and 168 in 1937. Weighed 167 last winter (1939).
646 Never lost weight in the summertime before last year (1939). I am in the wire-making business. I never
647 missed any days from work in 1939 and only days lost
648 in 1940 was when laid off. Yes, I said I became naus-
649 eated from the odor. Do not understand what "nauseation" means. Don't vomit because I don't eat much—eat only certain food and keep it down. I have never consulted any doctor on account of my loss of weight.

650 LYDIA ERICKSON, I live at 812 Kammerman Ave., Joliet, Ill., about a mile and a half from the canal and have resided at this address for 17 years. Condition surrounding the canal in 1939 was terrible. Noticed an odor in 1937 and 1938 off and on at night mostly. The odor was more offensive in 1939, it was terrible, could
651 hardly stand it. Was sick every night. I couldn't sleep nights and during the time I smelled it my throat was sore, I couldn't eat in the morning and I got nervous from it. I was nauseated to my stomach. I vomited from it and had headache. These symptoms occurred

when odor was present from canal. At times when there was no odor they might occur a little, but not like at
652 that time. Went to Dr. Earl Steen. There were days last summer (1939) when I had to lay down a good deal at times. These symptoms from the odor happened prior to 1939 but not like they have lately. This year (1940) I have been a little better. I noticed the odor at my
653 home last night (July 22, 1940). It started last night after eleven o'clock. Before eleven o'clock, well, off and on. When the wind is in that direction I can smell every bit of it all day and all night long. Dr. Steen has been my family physician for 25 years. The last time I went to see him about myself was the last part of
654 last year (1939). My health is pretty good and weight in 1940 is about the same as last year (1939).

July 23, 1940

655 MRS. ROBERT MITCHELL, I have lived at 201 No. Broadway, Joliet, Ill., a little past two years. Have lived in that neighborhood 5½ years—block and a half west
656 of the waterway. Conditions of the canal last summer (1939) just unbearable compared with those prior thereto. Every night my husband would have to bring me something because I couldn't get up—I would be so
657 sick, vomiting every night. My little boy vomited day in and day out last summer (1939). In June this year (1940) I had to keep him home from school—he had a fever. Vomiting by the boy would occur when the
658 odor was perceptible in my house. I myself experienced this vomiting just in 1939 and again a couple of times

in June this year. I haven't noticed conditions so much this year—have had cool weather, but last year (1939) it was terrible. My husband was ill last summer (1939).
659 He broke out in large sores on legs and arms and had continual headaches. He was not ill last winter (1939). In June this summer (1940) he had the same thing—sores on his arms and legs. He is better now. Prior to
660 1939 she noticed it some, but had never been sick from it until last year (1939). In response to question "Did you lose any weight?" the witness testified—"Oh, no, I never lose weight, no matter what". I have not worked
660 so far during 1940. My husband made me quit work in October 1939 on account of being sick every night.

662 MISS MARY McGARRY—I live at 24 North Broadway, Joliet, Illinois, about a block and a half from the waterway. I have lived at this address 35 years. There was a piece in the paper asking for objections and I felt it was my duty to write in to the Health Commissioner and object to the odor from the canal. The
663 odor bothered me plenty. Conditions surrounding the canal were the worst in 1939. This year (1940) is not
664 quite so bad. The odor makes it hard to get to sleep, otherwise I don't mind. I have a good stomach and can't say with truth the odor nauseates me. My complaint goes solely to the stench. Last week and last night (July 22, 1940) conditions was very bad.

666 MRS. ELLA ANDERSON, I live at 812 Kammerman
667 Ave., Joliet, Ill. I have lived at this address eight years. Conditions surrounding the canal in 1939 were definitely worse than in years prior thereto. The odor makes a

person sick to his stomach—you don't feel like eating and you lose sleep. Last night (July 22, 1940) it was terrible and lasted quite some time. Can see the waterway from my back porch. Last year (1939) the locks to McDonough Street Bridge, and sometimes on the
668 other side, were just thick with scum. When the sun beats down on that scum you naturally get a terrible odor. By this I have, to a certain extent, been affected with a loss of appetite. I did not have that loss of appetite during the winter. I have it when the odor is present. This year the weather has been marvelous up to this last week. We had a case of it then and again in
669 June when we had a few days of hot weather. There wasn't so much scum on the canal in the years before as there was last year (1939). I was nauseated and felt sick at my stomach. My daughter was the same. I do not notice that condition at any time other than when I smell the odor. Health is comparatively good
670 and I feel pretty good. Last night (July 22, 1940) was
671 a splendid night for the odor. I was nauseated last night
673 to a certain extent but didn't actually throw up. Odors were prevalent before 1939 but they were not as bad.

677 MICHAEL COSTELLO. Have been in the meat and
678 grocery business at 701 So. Joliet Street for ten years. I have lived at 508 So. Joliet St., Joliet, Ill. for 14 years.
679 The canal is three blocks west. Condition of the deep waterway canal in 1939 I think was about the worst it has ever been. I myself felt it more in 1939 than in the previous years. I had stomach trouble—vomiting complaints. This summer (1940) I haven't noticed that yet because the odor isn't bad—have had such cool

weather. I have not had stomach trouble in the winter. This condition is present only when the odor is present. Last summer (1939) all the family had diarrhea. The odor bothers our sleeping—we have to keep the windows shut regardless of how warm it is, to keep the
680 odor out so we can rest at night. It has affected my business too—people think I am not keeping a clean
681 place—there is an odor in my place of business. I think the odors last year (1939) were worse than in 1938. I believe a man could walk on that water, that is how thick it is. I didn't notice that condition prior to last year (1939). I think the odor was constant last summer (1939). I was bothered with stomach all last summer (1939) since the hot weather came into effect. Lasted till the cool weather came. I just doctored myself.

684 CHARLES SANTINI, I am in grocery and meat busi-
685 ness at 515 So. Ottawa Street, Joliet, Illinois and have resided at this same address since 1925, three blocks east of the canal. I did not live in Joliet prior to that time. I noticed the odor from the canal last summer (1939). A year before (1938) it seemed to me it was stronger but it was also bad last year (1939). This year (1940) it don't seem so strong so far because we are just beginning to get in the hot weather. Other than
686 smell, it does not effect me. At night when the wind
687 blows, lot of times I can't sleep. Am 55 years old 5' 5" tall, weigh 204 pounds. Weight was about 209 last year (1939).

688 WALTER BRITZ, I have resided at 260 No. 12th St., Joliet, Illinois (corner of Western & Bluff) since

689 about 1929. Back end of the place is about 40 feet away from the canal. Condition of the canal in 1939 was worst we have had. Scum thicker and heavier and just gradually moving. In the years prior to 1939 it seemed to be going along faster and there wasn't as bad an odor. Odor bothers my stomach—nauseates me and I can't eat.
690 Vomited as a result last summer (1939). In the winter you don't get the odor. Wife was nauseated last summer (1939). She was nauseated when the odor was present. There were millions—billions of mosquitoes around the canal last summer (1939). I did not notice
691 them in prior years as bad as last year (1939). The odor last year (1939) was practically constant all during the summer—the hot weather. Conditions this year (1940) aren't so bad—last night (July 22, 1940) was the worst. Only during the hot days this year have we had it. The older boys don't want to eat anything. Four
692 children in family—only the oldest being affected. The youngest ones don't realize what the odor is. It didn't
693 bother the youngest one. My health is good outside of my stomach. Weigh about 162 or 5 now. Height 5' 8½" or 9". Family's health is generally good.

693 WILLIAM KERWIN. I have resided at 205 No.
694 Broadway, Joliet, Ill., about 9 years. I have observed conditions on the canal during the years I have lived around there. Last summer (1939) was the worst of them all. The odor was more offensive. Would make me sick at my stomach if I was standing around when a boat went through churning it up. Vomited a few times as a result of the odor. Appetite affected—sick to my stomach—couldn't eat anything. Did not notice the

odor at nights. It does not affect my sleeping. This year (1940) it has been all right; better this year than ever before. I did not notice it last night (July 22, 1940). I live about a block west of the canal. Age 46 years, height 5' 6" and weigh 175. Used to weigh 188. Outside of last summer (1939) my health has been fine. My stomach was kind of upset during the war. I would go along in pretty good shape until a boat comes through in hot weather and churns up the water. Don't blame it all on the river.

JOSEPH BOLTE. I have lived about a year at 756 No. Bluff St., Joliet, Ill. Formerly lived for seven or eight years at 817 No. Bluff St., about 50 feet from canal. We had a lot of illness in my family a couple of summers ago (1938). My son Jimmie had a rash in the summer of 1939. No one else had any ailment. The children last summer (1939) got summer complaint and stuff like that. I have Dr. McGinnis now for my daughter—she claims she can't eat. I noticed the smell last summer (1939). When it is colder weather it ain't so bad, but it stinks in the hot weather. I noticed it last night (July 22, 1940) especially when the boats come. The smell this year (1940) wasn't so bad as long as the weather was cold and it was raining all the time—now it is beginning to smell. Doctor gave the children shots to keep them from getting typhoid when they were ill a few summers ago—not last summer (1939). The waterway always had a funny smell during all the time I have lived there.

Tuesday, July 23, 1940.

NELLIE PATTERSON HANSON. I have resided at 208 West Marion Street, Joliet, Illinois off and on for about 50 years with a brother and sister. Live about half a block west of the canal. I have had occasion to notice the canal for many years. In 1939 my sister was in bed for six weeks as a result of the smell. She suffered from nausea, loss of appetite—just general disability. I, myself also suffered from fainting mostly. The smell was so terrible it went to my head. I noticed the offensive nature of the odor in 1938. Further than that she couldn't tell. Conditions in 1939 were worse than in the years prior thereto. The odor would last sometimes all day and all night—worse when the boats were going through. Dr. Patterson—my brother—was physician for my sister. We had other counsel too—she was very seriously ill. Odor has affected my sleeping. We have to close the doors and windows. Last Sunday (July 21, 1940) it was unbearable. Had to leave home for the day it was so bad. Last night (July 22, 1940) wasn't so bad.

MRS. JOSEPHINE CRESPI. I have resided at 335 So. Joliet Street, Joliet, Ill., about 26 years—east side of river. Think condition or odor of canal in 1939 was worst year we ever had. The odor was much stronger. It would last sometimes all day and sometimes almost all night. It wasn't a constant odor—it came and went. The odor would sometimes make me sick at my stomach. Health of my children last summer (1939) was all right. At times in 1940 I have suffered from the odor.

The middle part of May a day was awful bad. I did not notice the odor last night (July 22, 1940). When it is hot the odor makes you kind of sick and you really can't sleep. Have to close the windows. I have been under doctor's care for ten years now.

709 MRS. GERTRUDE MUENTNICK. I have lived at 33 No. Hickory St., Joliet, Ill., for three months about a block and half west of canal. Prior to that lived at 208
710 So. Raynor Ave., about one and a half years, and before that at 110 Illinois Street for 16 or 17 years, about four or five blocks from the waterway. I have lived in Joliet for 32 years. The Raynor Street address is five or six blocks west of the canal. I was sick in August and September last year (1939). It was my stomach and
711 just gagging all the time. Consulted Dr. Faulkner. Some nights the smell was worse than others. We couldn't have our windows closed, we had to have air, so the smell was there all the time. The odor on a day I consider it offensive is sickening—I become sick to my stomach and nauseated. I have noticed the odor only a few
712 days in 1940. It hasn't been warm. I think the odor in 1939 has been the worst it ever was. I never before
714 had anything like nausea prior to the summer of 1939.
715 The odor in 1939 first became noticeable to me in August and September. I have not suffered from nausea in 1940. The smell wasn't so bad that it would affect anybody yet. I consider 1940 better than 1939. Health now is fine.

Tuesday, July 23, 1940

MRS. LAURA CERVELLOTTI, I have lived at 342 So. Jefferson Street, Joliet, Ill., 23 years about two blocks from waterway. I noticed odor given off by waterway last summer (1939) more than this summer (1940). It was stronger. There was only one day this summer (1940)—I forget—May or what month it was. Odor did not bother me in 1939. I never got sick to my stomach like I did one day this summer (1940) in May. As to affecting sleep, a lot of times I put the window down to get rid of the smell. No one else in my family was ill during the summer of 1939. Conditions this summer (1940) are not so bad—just the one day I told about—and that was only a second, just made me sick to my stomach.

MRS. CATHERINE LAWLER. I have resided at 508 No. Broadway, Joliet, Ill., for two years—about a block and half from waterway. I have four children. My nine year old son was ill last summer (1939). Has the asthma. I noticed the odor from the canal last summer (1939). I noticed it first about the end of July and then it got worse during August. We never lived up there (508 N. Broadway) except just to sleep because we were down at my mother's most of the time. My mother lives down on Ottawa Street—about 6 or 7 blocks from the river. I did not notice the odor at our present address last summer (1939). I noticed it this summer (1940) about three weeks ago and once a week ago Sunday. Last night (July 22, 1940) it was terrible. I was awful restless between the heat and the smell. It lasted about

three hours. My son has had asthma a year now in August (1940). We go down and spend the day with my mother because my children have no yard to play in. We smell the chemical works down there but can't smell the canal. I think the odor from the canal is more offensive than the chemical works. Smelled it (the canal) so much last year (1939) that we are used to smelling it.

JOHN PELLINO, I am employed as pilot of a tugboat on the river. I have been working on the river about six years. I reside at 1406 No. Broadway, Joliet, Ill. Have lived there about four months. I believe the condition of the canal was a lot worse last year (1939) than it is this year (1940). It was pretty bad last year (1939) most of the time. I am really accustomed to it now. Just about three weeks ago I was running up the river with a light boat. Had the window in the pilot house open. Passed another boat and waves splashed water in through windows and on my face on which I had some cold sores. Sunday morning my jaw was swelled up and I went to the doctor. Had a deep abcess on each side of my face. The swelling did not occur the next morning. Last Sunday (July 21, 1940) was when I first noticed it. I was hit by this spray within two weeks. I think the scum and sludge deposits on the river in 1939 was a little less than the year before (1938). 1940 is about the same as 1939. Conditions in 1939 as to the amount of sludge were better than they were in the earlier years, figuring back to 1936 and 1937. In 1936 and 1937 there was high as two, three inches of scum in Lake Joliet here. You could see the

water bubble up, big bubbles of gas—bubbles of some kind. Very seldom you see it now. I was working more around Joliet then and noticed it more. Last summer (1939) was working between Lockport and Chicago—didn't get down here very often. During the summer months—May to September—last year (1939) I was down to Joliet by boat on the canal approximately ten times. I have spent six years on the waterway and my health is good. During the six years I have lost approximately a month's time on account of illness. I was sick in 1935 or 1936—don't know which one it was. Then in 1937 went home a couple of times for a day or so and then this year (1940) a couple of times. Stomach wasn't working right and I had to lay off for a couple of days. Nothing serious. The smell would cause it, I imagine. It gets so bad sometimes right where it is bubbling up that it upsets you. The waterway has given off odors the six years I have been on it.

MRS. RAY SWANCO. I reside at 211 No. Center St., Joliet, Ill., three blocks from the river, and have liver there three months. Before that I lived at 313 Bluff St. right across the street from the river on west side. Before that I lived way out at Ridgewood on Harwood Street on east side. I noticed plenty of odor from the canal when I lived on Bluff Street. We had to shut the windows most the time we lived there, during April, May and June 1939. We moved from there because we couldn't stand the odor—upset our stomachs most of the time at meals and at night we could not sleep. Odor affected us just about all the time. We nev-

749 er noticed the odor out in Ridgwood. We haven't noticed it so much this summer (1940) at our present address—only last night (July 22, 1940) there was a terrible odor. I think last night is the first time we have
751 noticed it for the summer. My health isn't what you could call good, but I really can't blame it on the river right now.

752 ANNA MARIETTA. I live with my brother and two sons at 310 So. Joliet St., Joliet, Ill. Have lived there about 18 years. This is about block and half from canal.
753 I have noticed odors from canal a whole lot this year (1940). I noticed it last week—had to get up and put my window down. It was a real strong gas smell. Last night (July 22, 1940) I got a whiff—it was a different odor. Conditions in 1939 was just as bad as this year (1940). Every once in a while we would have this smell
754 coming in. We would have to close the window. The unpleasant smell would just keep me awake. It did not affect my appetite in any way. Last year (1939) seemed
755 to be worse. During all the time I have lived there I have noticed an odor from the waterway. My health is all right.

Tuesday, July 23, 1940

756 R. A. FOX, I have been employed approximately five years as Chief Engineer of Globe Oil & Refining Co.
757 Live at RFD No. 2, Lockport, Illinois about a mile from canal. The oil company uses water from the canal for cooling purposes at their plant. The sludge or sediment

from the water settles in condenser boxes and men under me have to clean out this sediment at periods and they thus come in contact with the water and the sediment when they go down in there. There is a very strong appreciable odor given off. We always have
758 trouble when we clean those boxes. Have innumerable cases where the men have to climb out and go lie down, sick and blue. I noticed very definitely an increase in the intensity of the odor last year (1939) during the hot weather. I haven't noticed it as much this year (1940) as last due to fact we haven't had the hot wea-
759 ther. We have found skin eruptions after men have been in contact with water over in our plant. Especial-
764 ly with open sores we had cases of infection. We have been taking water for a number of years. We have not always had the same kind of experiences with our men as I described. We have noticed definitely the difference in effect on the men in approximately the last 12 mnoths. I haven't noticed the odor so much this year (1940) as last (1939). The offal and debris in the canal
765 I would say, is somewhat worse. Before 1939 I cannot recall of any case where men had to lay off because of the ill effects I described. During 1939 we had to send two or three men home about every two weeks (they work on their intakes about every two weeks).
766 They were home for the night and were back the next
767 day. I work right alongside the canal all the time and my health is all right. There has always been an odor from the canal during the five years I have been there.

768 WILLIAM M. DENEAU, submarine diver and construction forman. I have resided at 506 Oneida St., Jo-

liet, Ill., about 12 years. Helped build the waterway. Have been on it ever since the contractor started building it. I am now employed by the United States Engi-
769 neer at Joliet. I take care of any kind of a job under water. I generally cover the area from Joliet to Starved Rock. I have frequently gone below the water in the
770 canal off Joliet and in Brandon Pool and at Brandon locks. I would say I have been down in Brandon pool
771 five times since January 1939. I stay under the water half a day at a time—sometimes five or six hours without coming up. Before they cut the flow (December 31,
772 1938) when they had a little more current I could see a little bit under water in some places when the sun would shine. Now you might as well stay inside of a closed closet and try to see. In Brandon pool the muck down there in some places is four, five and six feet deep, seven feet deep. In reply to the question "Has it affected your health" the witness states "Well, like the fellow
773 says, you can work in a sewer for a long while and you get used to it". I have to keep in condition pretty good. I work with my bare hands and get cuts on my hands. Every time I get a cut I take care of it myself—sometimes if it is bad, the government doctor takes care of it. The government is real strict. Any time we get cut —any kind of a cut—we must report it and must have a
774 disinfectant to put on their hands. The air pumped down to me is taken from right above the water. The air from Brandon locks pool gives me a headache and when they are emptying the locks the fumes from that water stirring up makes me kind of sick. When they
775 had more water they didn't have that disposal plant working and there was a lot of stuff in the water—

practically more than there is now, but the current kept a-sending it down the river—a lot of it went over and didn't settle in the pool. Since they cut the current down almost everything settles in the still water
776 of these pools and that is where most of the muck stays. The gases in 1939 and 1940 have been worse since the
799 water has been still. At night time they have a pretty good current, and they use that, the powerhouse is using more water and they are letting more current down. In the daytime around four, five or six o'clock they cut down the turbines and that leaves less current. There is always a little current on the surface—but below six or seven, sometimes three or four, feet down, there is
801 none. I am 51 years old and weigh about 180.

802 ARTHUR RESIDORI, I am unemployed at present,
803 I have resided at 410 No. Bluff Street, Joliet, Ill., for 11 years—on west bank of the river about 75 feet from canal. My oldest child, aged 10 was ill last summer (1939). She had sinus trouble. My wife complained of headaches, sore back and pains. She has been doctoring
804 for a bout a year. Since 1939 we have been getting the odor from the canal pretty bad over where I live. It bothered me, you might say, every day last summer (1939) when it was really warm. Could smell it right along. I have been having headaches last summer (1939) and this summer (1940). In the wintertime it isn't so bad. Also affects my stomach—stomachaches. I
805 noticed the odor prior to 1939. Last summer (1939) it was more offensive than it was before that. I did not have headaches the summer before last (1938). This summer (1940) my girl's face was all swelled up—

rashes—and she must have touched it with her fingers
806 and it got all over her face. I couldn't sleep last summer (1939)—couldn't keep the windows open. Last night (July 22, 1940) I couldn't sleep. I had a headache at twelve o'clock.—got up and went out on the porch until four o'clock this morning. The odor was terrible last
807 night. My health is pretty good—only trouble is with my stomach—I get them pains once in a while. I never vomit. Weigh 178 or 180 lbs. am 5' 7½" or 8" in height.
808 I never lost any time from work from any of these stomach pains. I cannot smell any odor in the court-
809 room. I have headaches in the wintertime too—just get them when I get this smell. I get the smell in the win-
810 tertime but it doesn't smell so bad. My age is 35 years
811 and I have never had a doctor. My oldest child had vo-
813 miting spells last summer (1939). She has sinus trouble. In the eleven years I have lived at this address I never noticed the odors from the canal until last couple of summers (1940 and 1939) before that never once.

Tuesday, July 23, 1940.

814 OTTO BOSWELL, I have resided at 407 Patterson View, at the south end of Joliet about a half mile east of
815 the canal for nine years. My youngest child, aged 7, was ill last summer (1939). Had kind of spots all over
816 her body. I never took much notice of the odor from the canal until this summer (1940). Between the canal and the chemical works we can hardly stand it on a still night. It interfered with my sleeping some last summer (1939). The odor is noticeable only when the
817 wind would come from west-north. My home is located below the level of the canal. The odor this summer (1940) has been pretty bad last few hot days we

had. I don't know that the odor has any effect on me. Went home with headache last Tuesday (July 16, 1940) but wouldn't say that was the cause of it—the heat.

818 LEROY SHERMAN, Superintendent of Swift & Co. I reside at 346 So. Ottawa St., Joliet, Ill.—three short blocks east of the canal. I have lived there for seven
819 years. Am married and have three children, aged 10, 8 and 6. I noticed the odor from the canal during the summer months of *1939*. It was more offensive than it had been in past years—in fact, I hadn't noticed it in the past. It affected my appetite at times, when the smell has been bad I haven't felt like eating. It has in-
820 terfered with my sleeping on several occasions. My oldest daughter was ill last summer (1939) from loss of appetite and loss of weight. I took her to a doctor and he gave her a tonic for that. I don't know whether it bothered my wife as much as it did me—couldn't say
821 whether she slept well last summer (1939). The odor was not so noticeable you would pay any attention to it prior to last summer (1939). In the wintertime I don't notice it. I have not noticed it much until just lately in 1940. When it is cool you don't get it like you do if it is warm. There was an odor last night (July 22,
822 1940) but not as strong as it usually is. I have noticed if we send my daughter away for a month or so, she seems to pick up and start eating and after she has been back home a week or so she is off her eating again. In
823 the winter she seems to be all right. It doesn't seem to bother the other children. My general health seems to be
824 good. The heat last night (July 22, 1940) was keeping me awake more than anything.

825 MRS. OPAL RENKENBERGER. I have resided at 708 West Jasper Street, Joliet, Ill., for 14 or 15 years—five or six blocks west of the canal. I have noticed odor from the canal this year (1940) the latter part of May and in June—then it hasn't been bad until the last week. My older daughter has asthma and we have been sending her away every year around the middle of
826 July or August. This year (1940) we had to send her away the last week of June because the air was such she couldn't stand it. She had to set up in bed a lot at night from the air. I think the atmosphere in 1939 was more offensive than in years prior thereto, as I remember. This year (1940) the season has just really begun. Odor interferes with sleping very much and with eating, especially in the evening. The odor is very offensive—you kind of lose your appetite. Last summer (1939) we were bothered practically every night with it. I didn't notice it so much during the forepart of the day, but by midafternoon and all night we notice it very much.
827 I have seen the sludge completely cover the river at McDonough Street bridge. It looks so thick that you
828 might be able to walk across the water on it. My daughter has had hay fever and asthma for about six years. We have been sending her away in the summer for five years now. My own health is all right and I wish I could suffer from loss of appetite.

829 MRS. PALMA POLMONARI, I have lived at 408
830 South Water Streeet, Joliet, Ill., for two years—right across the street east from the river. I noticed the odor
831 last summer (1939). I had headaches and it travels through my neck and down my shoulder and sometimes

it bothers me awful. I get that headache when it is hot weather like today and yesterday. I smelled the odor over where I live today (July 23, 1940). It started about nine o'clock last night. It affects my appetite—but my children most, the little ones. They refuse to eat when
832 I give them food. They eat in the wintertime. The time they refuse food is on the days this odor comes by. We haven't had much trouble with it this year (1940) but when you sleep you cannot sleep. The odor comes right in through your windows. One child—the little one—for about three days now she won't eat at all. Its from the odor. She has trouble sleeping too. It
833 doesn't bother the two oldest. Hot weather does not bother my appetite. I eat as much in hot weather as in cold weather. All the time I have a pretty good appetite. I know when to eat. When the smell is there I can't eat. I do not know that I have lost any weight in the last couple of years. My general health is good.

834 DAN STOBBEONA, I have lived at 502 So. Joliet St., Joliet, Illinois since about 1921. This is on the east side of the river. I have been bothered by the odors
835 from the canal for three years now. The odor three years ago wasn't as bad as it was two years ago and this summer (1940). I have noticed it more this summer (1940) than last summer (1939). Right now where scum is so thick in there, you can walk across the river
837 without a boat. You can see that way down by Brandon's bridge. I am getting sore throat and sinus trouble and you can't eat with that smell. I have been going to
838 Dr. Margliano for a year. I am going to see Dr. Lennon, a specialist for throat and eye tonight (July 23, 1940).

I am a machine operator for American Steel & Wire Co. I work every day. Sometimes if don't feel good I stay home. The only thing that bothers me is my throat and head. That has bothered me for three
840 years. Last year (1939) on the river it was pretty bad. Year before last (1938) wasn't as bad as last year (1939). The year before that (1937) it doesn't stink as much as it does now because we had more water float-
841 ing through. This year (1940) is pretty bad. It is as bad as last year (1939).

Tuesday, July 23, 1940.

845 MRS. LOUISE GARAVOLIA, I have lived at 20 Duncan Street, Joliet, Ill., for 25 years—about 4 or 5 blocks from the canal. I have noticed odors from the canal during the years 1938, 1939 and 1940. 1939 was terrible. We could not sleep unless we lowered windows. We never could sleep with windows open when it was warm. It was worse in 1939 than it was in 1938. It hasn't been so bad in 1940, but we haven't had much hot weather. It has been bad since we had hot weather. Had some bad nights in May and June and last
846 night (July 22, 1940) was a bad night. It gave me a nauseated stomach. I have three little grandchildren that lost their appetites. Last year I had them sick with dysentery three or four weeks. The odor affects their appetites—they just don't want to eat. I do not believe it is as bad today (July 23, 1940) as it was any time in 1939. One or two days I smelled it awful bad
847 this year—as bad as in 1939. I have not smelled it as

much this year (1940) as I did in 1939 because the weather has been cooler. The children this year are not eating so good but I am blaming it on the warm weatner this year (1940) right now. Otherwise they have been pretty good until last week or so. They have been eating better this year (1940). We had a very warm summer last year (1939) and hot weather sometimes affects children's appetites. My own health is good except for nauseated stomach from the odor when I get up in the morning. I haven't lost any weight that I
848 know of. The odor noticed so far in 1940 has been noticed mostly at night. In the daytime I am working and I do not seem to notice it so much. It starts early in the evening.

849 MRS. IRMA BUSANELLI, I have resided for two years at 404 South Water Street, Joliet, Ill., on east side
850 of canal. I have smelled the odor from the canal the last two years. I didn't smell it before because I lived far away from there. The odor was bad last year (1939) and this year (1940). Now I start to get used to it. It is bad because we can't sleep. If we close the windows we can't sleep on account of the heat. It makes my head
851 ache and makes me throw up whenever the wind blows from the west. It bothers the rest of the members of my family too. The kids jump around all night—can't sleep on account of heat. I do not think I have lost any weight—it is my nature to be fat. My general health is good.

852 CHARLES DONNA, I have resided for about 15 years at 809 Adler Street, Joliet, Illinois—about a block from

Brandon pool. The smell from the canal was worse last year (1939) than it was in 1938. I never noticed it much
853 this year (1940) yet. We have had no hot weather. We have had a few bad nights but not like last year (1939). Last month (June) we have a few nights and now lately we have a few nights. It is pretty hard to sleep because of the odor, if you keep the window open and it is hot. I have to cut down eating when I get that
854 smell—lose my appetite. It never bothers my children much—just bothers me and my wife. I have lost no weight. Weigh about 180, am 5' 7" tall. Health all right until last year (1939) when I started to get up in the
855 night and vomit. I am a tavern-keeper. Have never lost any time from work.

July 23, 1940 (Tuesday)

859 EDWARD P. CALLAHAN, I am 62 years of age, I
860 am employed as U. S. Lockmaster at Lockport, Illinois
861 since May 1, 1932. I live in a government house right alongside the lock. I came there and painted some towers in 1930. At that time the water out there (pointing to water on north side of lock) was thick—you could
862 almost paint with it. It was filthy. Then there was an awful stench. We almost had to get clothes pins and put on our nose. Conditions today (July 23, 1940) are nowhere near as bad as they were then. They have been clearing that water up—cleared up I would guess 60%. Would say condition today is better than it was a year ago. Do I look as if odor had affected my health? My wife lives with me and two grandchildren, aged 4 years
863 and three months, come down quite often to see me. Neither of them have been affected (by the odor) by

visiting me. They are the picture of health. I have lived alongside the canal for the past year—prior to
864 that I lived in the town of Lockport—about two miles away. My grandchildren have slept at my house.
866 I cannot say that I have suffered any ill effects. I did not live at the locks last summer (1939) at this time
867 (July) but I worked there every day. The condition in 1939 was much less than it was in 1930 and 1932. There
868 was no such condition there two years ago as there was ten years ago. The cut in the flow has made no difference in the condition of the waterway so far as I have observed it.

869 HARRY MOHR, I am 44 years of age, and am employed as Lockmate at the Lockport Lock. I have been employed there four years, working right alongside the canal. I do not smell anything right now (July 23, 1940). I think conditions as I observe them are now better than they were last year (1939). My family and I live three-fourths of a mile from the canal. My wife
870 and daughter have suffered no ill effects from the canal. I have not smelled anything today—imagine working there I get used to the odor and pay no attention if there is an odor. I have fallen in the water several times. It has caused not a bit of ill effect.

Wednesday, July 24, 1940

876 DR. THOMAS H. WAGNER. My office is in the
877 Medical Arts Building on Scott Street, Joliet, Illinois. I have practiced in Joliet for 40 years, specializing principally in surgery. Mrs. JOE AVON has been for a number of years and still is a patient of mine. (Mrs. Avon

is the wife of Joseph Avon, a witness whose testimony appears at pp. 612-616 of Record). Mrs. Avon consulted me during the summer of 1939. She has always been troubled with more or less nausea and vomiting and general rundown condition. I could find no organic
878 basis for that condition. She seemed to be worse when the air was heavy with odors from the Canal and I felt her condition was due to the state of air. My home is
879 the east side and I had occasion to observe that odor last summer (1939). Even last night (July 23, 1940) it was terrible. I do not think any explanation is necessary as to how such an odor could cause vomiting, headaches, or loss of sleep. Any foul odor will make
880 one sick and aggravates the condition of one inclined to be ill anyway. I found this so with other patients many times. Such an odor would unquestionably retard recovery from illness. From my own experience at home—where we have to close the windows if we want to enjoy a meal—I know odor will affect the appetites of individuals. I feel the condition of the Canal since 1939 is absolutely a menace to health of the community of Joliet.

881 I am the government surgeon and take care of many of the men who work on the Canal. They have had many cases of skin diseases, pustular eruptions and boils involving the exposed portions of the body. I have had to take them off their job for a while and apply protecting oils to their arms, hands and face. It is all traceable to the foul water where they come in contact with it.

The odor from the Canal since 1939 is decidely more intense. The water (from the canal) is terribly in-

882 fected with all forms of bacteria and fungi and most of these pustular skin diseases are due to fungus infection which the water is loaded with. I am on the staff at St. Joseph's Hospital and they have complained many times about the odor. It is natural to suppose the odor has an effect upon the patients at the hospital.

883 I think the waterway as it has existed since 1939 is a
884 menace to the health of the City of Joliet. The basis for such conclusion is that when a physician is called into the home of a patient and they become progressively worse following the inhalation of bad odors, you naturally think the odors are menacing their health. Then you have got to close the windows and doors to enjoy meals.

By "nauseating odors" I mean it makes you sick to
885 your stomach. Not every person—some people can stand those odors—others cannot. Some people can stand terrific odors—but one who is a little bit ill from another cause, no matter what it is—let him breathe bad
886 odors and that naturally makes them worse. I observed these odors last night (July 23, 1940) around 6:30; I live at 309 Sherman St. about six blocks from the canal; then again about 10 o'clock when we came home and turned on fan on our sleeping porch. I did not observe
887 it constantly all evening. My definition for "nausea" is sick stomach. It would take me an hour to name the common causes of nausea; there are so many common causes. I never examined the river to determine the pollution or bacteria in the river. I have had a number of patients who went into or fell into the river and everyone of them vomited and upon examining their vomit it was full of colon bacilli, typhoid and other bac-

teria. The human system normally is full of colon bacilli—but not foreign colon bacilli; you are immune to
888 your own practically, but not to others. When it comes out of their stomach, I know they must have swallowed it. Nausea and feeling of illness is only trouble I can testify to that would be caused by odors. When the odors were eliminated or kept out, nausea and feeling of distress disappeared.

889 The river has ben polluted since 1900. The raw sewage of the City of Chicago has been carried down this stream through the City of Joliet. We have always had with us cases of skin trouble, boils and eruptions prior
890 to 1939. Odors since year or year and half ago have
891 been much worse. The objectionable odor in 1940 is about the same as we had in 1939. I did not have any
892 trouble to amount to anything with odors prior to 1939. I must honestly state I don't believe the condition here is a menace to the health of the average healthy individual. It certainly is a menace to the health of the individual who is not strong and who is ill from other causes. It certainly shortens their life. I could not show a specific record of any case where unhealthy individuals have had their lives shortened by this experience here. We don't make a record of that because we
893 never expect to be called upon to show such a record. I believe Joliet is generally a pretty healthy community—as good as the average. Some of the people who testified here of their inability to eat and sleep and who look healthy and seem to be tending to overweight will thrive on those things—it takes germs to make some people thrive and others don't.

896 A normal individual in the presence of this odor

would not necessarily become nauseated. It depends upon whether he is susceptible to that odor. Some people are susceptible to the odor of a rose which is sup-
897 posed to be perfume. They become nauseated and sick. My experience with men with sores has been the case ever since the men have been working on the canal—a number of years, but they always had more cases when sludge was worse. I had a lot more cases in 1939 than in previous years. Have not had as many
898 cases in 1940. The number of men working now of course has been reduced. The trouble with the odor is always in the summertime. Never seem to notice it much in the winter.

905 MRS. BEULAH BOOKLUND, I resided for three months at 115 Wheeler Street and before that for about 16 years at 610 Railroad Street, Joliet, Illinois, on the west side of the river about half block from the canal.
906 Moved from Railroad Avenue address because we could no longer stand the odors and fumes destroying things in our house. Odor bothered me for first time in 1939. Never noticed it prior to that time. The odor was just so terrible I can't explain it. It was the worst smell I ever smelled. It caused me to have headaches and nausea. It affected my bronchial tubes. The close proximity of the canal in 1939 ruined the paint on our
907 house. This gas turned the paint on the houses around there all black. All of the buildings around there look the same. Did not have that discoloration prior to 1939.
916 1939 was the first season. I did not suffer from nausea during the summer of 1938. Did not suffer from it so much last winter (1939). During the summer the heat

makes the odor and the fumes worse. I do not know how far from canal 115 Wheeler Street is. It is about three blocks off of Raynor Avenue. Odor at new home this year (1940) is not quite so strong. We do get it up
917 there but not like we did where we lived before. Never observed the odors prior to 1939. I have been going to Dr. Faulkner off and on for about eight years.

927 DR. HENRY M. BECKWITH. I have practiced in city of Joliet since 1897. Reside at 623 Buell Avenue, about a mile west of here (hearing room).

I have a patient by name of Mrs. Jessie Marsh resid-
928 ing at 310 Broadway, Joliet, 78 years of age, who was subpoenaed to testify but whom I got excused because she was ill. I have been her physician for about 30 years. She came to me for professional advice in 1939. Diagnosed her condition as secondary anemia. I am familiar with and noticed a few times
929 the odor emanating from the Canal in 1939. That odor would be unhealthful to a person suffering from secondary anemia—it would reduce the resistance of the patient. The gases displace the oxygen of the blood
930 and that produces secondary anemia. The effect of the odor which emanates from the canal on persons convalescing from illness is anemia—displacing the oxygen in the blood. Mrs. Marsh is at home—she has
732 not been in a hospital. She is improving. She is almost as well as she will be so far as the anemia is concerned. At the present time she is in about as good shape as you can expect as far as the blood is concerned.

933 DR. GEORGE E. FAULKNER. My office is located in the Morris Building. I reside at 20 Manor Court, Joliet, Illinois; close to a mile from the canal on west side of river. I have practiced medicine in Joliet for 12 years.

934 I was consulted in September 1939 by Mrs. Gertrude Muentnech. She complained of nauseated feeling, very weak, generalized weakness. Made an examination of
935 patient and found nothing organically wrong. As long as nothing was organically wrong with her I came to conclusion her condition was due to the odor originating from the canal.

I observed the odor myself in my own home. I believe such an odor can produce such a condition of nausea and general listless condition because the river is stagnant, and on the surface of the river is all kinds of waste material. When the heat comes down on it, naturally it liberates these toxins and bacteria. It is likely to cause infection. We are liable to have a typhoid epidemic unless we get rid of that. Mrs. Muentnech
936 did have general listlessness. Personlly, I don't believe it is just the odor—but believe it is the toxins carried from the canal by the wind that affects the gastrointestinal tract and it affects especially the nasal mu-
937 cous membrance. I noticed that in last couple of years we are having more streptococcus sore throats and special nasal pharyngeal infections. I believe it is coming from toxins carried by the air off the canal.

The family of Michael Costello (a witness who testified in these hearings, at pp. 677-684 of the record) are patients but they didn't consult me about that. They just told me about it.

938 In the 6th Ward on a hot day, the odor sometimes would drive you away—it is terrific.

As to the effect of the odor on the people living in the 6th Ward, I think it is causing much more nasal pharyneal disease because inhaling the toxins the odor is carrying. I think the danger is not the odor so much
939 as it is carrying of toxins off the secretions. All types of infections come from secretions and the sun dries and will liberate some of them.

I am on the staff of St. Joseph's Hospital and have noticed the odor up there on the east side of the building. That is why most people want to be on the west side of the building. Patients have complained to me of the odor the same as they noticed the odor from any place. I do not feel, as far as the odor goes, it has any affect on retarding the convalescence of patients. I feel it is toxins carried by winds off the canal. Any toxin undermines the resistance and does cause a sec-
940 ondary anemia. One night I had to put down the windows at home on account of the odor. It was one of the hot nights early this summer (1940). Wasn't over a
941 month ago. I think the odor in 1940 as compared with 1939 is getting worse.

942 I have made no record over past few years to determine the number of people I have personally treated
943 for nasal pharyngeal diseases, but know that it is on the increase. The odor itself makes people miserable but it is my belief the toxins coming off spread the
944 trouble. Toxin is a poison liberated by bacteria. It can be the bacteria itself that is carried.

952 It has never been decided that typhoid epidemics come only from drinking water. It is my opinion the

953 waterway could cause any epidemic, even though none of the water is ever drunk, depending on the organism that is involved here. We are seeing many streptococcic throats in the spring and summer. Had a number of increased cases of that not over two months ago. It is not as bad now as it was some months ago.

954 As to the actual effect this waterway has had upon the health of the community, I believe it was not the odor so much as the toxins carried in the air that caused this one case I saw. That is the case of Mrs. Muentnech and the only one I know of directly. It has 956 never been proven that typhoid fever isn't carried in through the nasal pharynx. I know of no medical authority which holds the view that typhoid may be obtained by inhalation.

963 DR. PHILIP C. McGINNES, JR. My office is at 25 No. Ottawa Street, Joliet, Illinois. I have been practic- 964 ing medicine since 1936. I live at 1401 Colorado Avenue.

I recall the case of a man named Earhardt rescued 965 from the canal and taken to St. Joseph's Hospital. I 966 saw him shortly after he was taken from the water—a half to an hour after. The fellow apparently had taken 967 a considerable amount of water into his lungs. I saw the man twice that same day and the next day. By that 968 time he had developed aspiration pneumonia and a severe gastric upset. As near as I could tell, it was the polluted water that caused the severe gastric upset. The man died maybe 4 days after he was in the hospital.

969 I had a patient by name of Stephen Heinzel (a wit-

ness who testified in these hearings at pp. 617 of record). He came to me for treatment about five months ago. He had a streptoccal infection of the tongue. By
970 laboratory methods I determined that streptococcus
971 was the germ that caused the infection. Pried into his past history and only thing I could find that pointed to the possibility of exposure was the fact that he had gone into the water to rescue this Mr. Earhardt and might have gotten a little water into his mouth.

I had a patient by name of Emil Pianca. I treated
972 him for past two years. Believe his present complaint is listlessness—he had a groggy feeling all the time, loss of appetite and just not up to par. Came to me four or five months ago. I made an examination but couldn't find anything definitely organic. Mr. Pianca has a summer cottage and whenever he goes there he picks up, his appetite approves. He tells me he can smell this river and that is possibly what is back of his
973 loss of appetite. I cannot prove that statement.

It is a correct statement of medical theory that there are present in the average human throat many bacteria, some harmful and some not—and quite often there is
974 present the streptococci germ. These streptococci may
976 be transmitted from one person to another in numerous ways. As attending physician to Mr. Earhardt I signed the death certificate and cause of death was given as aspiration pneumonia. First time Mr. Heinzel came under my care five or six months ago something
977 like six months after the attempted suicide. I am still
978 treating him. There are many things that cause sore tongue; say, anemia, diabetes and what not.

(The Master observed that there was no reference by Mr. Heinzel in his testimony to sore tongue. He was asked how his health was and he said it was good.)

979 It is, right now because his tongue is getting along pretty good.

980 If Mr. Earhardt had fallen into Lake Michigan and had aspirated water into his lungs, he might have died of pneumonia.

987 MRS. MABLE ST. GERMAIN. I reside at 247 North Bluff Street on west side of Canal. I have lived at this 989 address for 17 years—right across the street from canal. 988 I was bothered by odor from the canal last night (July 23, 1940) about nine o'clock. It kind of makes me sick 989 to my stomach. Gave me an awful headache. I never noticed the odor prior to last summer (1939). Made me nauseated last summer (1939) but not summer before last (1938). Makes me feel like I want to throw up— 990 takes my appetite way. This summer, 1940, for last week or so it has been terrible. It is not so bad in the winter. I am not outside so much and we have doors and windows closed. I suffer from vomiting very much. Do not know my weight now—used to weigh 160. 991 Haven't weighed lately. Odor at night and early morning around five or six when I get up is the worst—especially when the boats go through. Of course I don't 992 lose any sleep over it. There has been an odor before 1939 but not as strong as what it has been lately. Never noticed it so much before. Didn't smell it so much this morning, (July 24, 1940). I am so used to it I do not

mind. I do not lose any sleep. It takes my appetite away in the morning—that is all.

993 MRS MARTIN RYAN. I reside at 26 North Broadway, Joliet, Illinois, on the west side of river about a
995 block from river. I have lived at this address about
993 five summers. Noticed the odor was terrible last night,
994 July 23, 1940. Not one of them, not even my husband, had breakfast this morning, July 24, 1940. Nobody could eat. The odor started last night after nine o'clock
995 and until four o'clock this morning. Last summer, 1939, it was terrible too. Didn't notice it prior to last summer, 1939. The odor makes me nervous—and tired, the heat along with it. In the cooler weather I do not notice it so bad. Complained to Mayor and Commissioner of Public Health last year (1939). Com-
996 plained a dozen or more times. I get up in morning and my brother-in-law upstairs over our apartment, would be up vomiting and we would be vomiting down-
997 stairs. I have lost no weight. Imagine I weigh around 157-58 pounds. Health is all right, I imagine. The odor first became offensive to me last year (1939). I have vomited before in my life. Odor causes me to lose sleep. Could always sleep well.

998 MRS. ELMA BIANCHI. I have resided since May 10, 1939 at 315 Illinois Street, Joliet, Illinois, on west
999 side of river. Prior to that I lived since December, 1936, at 521 South Joliet Street, about 3 blocks from the canal. I noticed an odor from the canal last summer (1939) but it wasn't as strong as when we lived at the Joliet Street address. We seemed to have more

odor down there. I noticed the odor before last year (1939) in about May or June of 1938—two years ago. We weren't affected as much on the west side (where they now live) as we were on the east side of the wall (where they formerly lived). It causes a burning sensation down thru the nostrils and down my throat. I seem to be more affected with it after midnight. Noticed it just during the summer months. Never experienced that sensation in my nose and throat prior to 1938. This year there was an offensive odor Tuesday morning (July 23, 1940). I use an ointment in my nostrils. Have not lost any weight. No other odor that I can recall has ever bothered me.

DR. RICHARD CALOSIS. I have been practicing medicine in Joliet for about 5 years. I have lived in Joliet about 22 years. I live at 302 South Chicago Street—five or six blocks from the Canal; located on east side.

John Pellino (a witness whose testimony appears at page 728 of record) is a patient of mine. He consulted me recently. He had cellulitis of the face. He had a red, browny swelling covering lower lip and most of the chin. After the thing was localized and opened up it was my opinion, both from the odor and the pus, that it was strictly colon infected. Mr. Pellino came to me on Sunday (July 21, 1940).

I have had occasion to observe the odor and condition of the canal. Noticed an odor at St. Joseph's hospital last night (July 23, 1940) around ten or ten-thirty even before I got near the place. As far as I can determine from my own observations, when the weather is particularly warm, patients in the hos-

pital object very strenuously to the odor. Think it does prolong the period of nausea and vomiting in post-operative patients—when they have the odor as pronounced as it is.

I have a patient whose husband works at the locks and every time she goes down there and the odor is the least pronounced she gets nauseated and gets attacks of diarrhea. That is her story to me.

1009 I would say that during the hot spell I noticed the odor more last year (1939). It was very pronounced and offensive at my home last night (July 23, 1940) after eleven o'clock or so.

1015 DR. EARL R. STEEN. I have been practicing medicine in Joliet, Illinois, since October 1899. I live on
1018 the east side—Ridgewood, approximately two miles from the Canal.

1016 Mrs. Lydia Erickson (a witness whose testimony appears at pp. 650-654 of record) is a patient of mine She consulted me in the summer of 1939. Her difficulty was a stomach and bowel disorder. Found nothing wrong with her organically. She had a high blood pressure and gastro-enteritis.

1017 It is my opinion that inhalation of odor emanating from the deep waterway canal prolonged her condition much longer than it should have been had she had good clean fresh air to breathe. The odor from the canal was sufficient to make her nauseated. She couldn't eat, therefore she was kept weak longer than if she had been able to take proper food.

1018 At times I have noticed the odor at my home. Noticed it last summer—1939. Noticed the odor last

year more than usual. Noticed it yesterday, July 23, 1940. Get it at times this year (1940) but not all of the time. There is no doubt about the odor from the canal deterring recovery from illness. Impure air is very detrimental to anyone. Sewer gases will make anyone ill. I feel that the canal in its present state and condition constitutes a menace to health of the community of Joliet.

I have treated a case similar to Mrs. Erickson. Had several last year—1939. Have had in previous years not only gastro-intestinal troubles but a lot of skin troubles which I think are due to the dry sewage that is spread over the county. Have been in Joliet for 40 years and we have had this sewer gas smell every summer more or less. I believe the general health of the community is fair.

MRS. ROSALIE HICKS. I have lived at 421 Rowell Street about 4 months, about two miles away. Prior to that for about two years off and on at 219 North Bluff Street, about a half a block across the bridge from the canal.

I observed the odor from the canal. Last summer, 1939, it was bad is about all I can say. I had terrible headaches and it caused me to become sick to my stomach. I did have headaches in summers prior to last summer, 1939, but not as bad as I did while living around there. I was not troubled with headaches so much during the last winter—1939. I am subject to headaches to a certain extent, but was down in bed two or three times after the odor was terrible around there. I had difficulty sleeping. Had to close the win-

dows and doors because the odor would come into the
1026 house. Have had slight headaches this year (1940)
during this heat spell. I did eat last year, but if odor
was terrible enough I couldn't keep my food down.
1027 The odor sometimes lasted a day or two and some-
times you didn't get it at all. It lasted usually a day
or so and mostly when the months are hot. Since mov-
ing away have had no trouble but was bothered while
living right alongside canal. Do not think I have lost
any weight.

1028 MRS. LENA PESTERIS. I have lived for 20 years
at 607 So. Ottawa Street, Joliet, Illinois, four blocks
1029 from Canal. I have five sons, the youngest aged 9
years. I and my sons all noticed the odor from the
canal last summer (1939). The youngest son got sick.
Family noticed it more last summer, (1939) than they
1030 ever did before. We had terrible headaches. It both-
ers my sleeping and eating. Have been bothered ever
since—but last summer, 1939, was worst for my fam-
1031 ily. Have not noticed it yet this year (1940). I weigh
147 pounds—lost three pounds in two weeks last year,
1032 (1939) but gained it back when it started to get cold.
General health is good.

1032 MRS. FLORENCE McCORMICK. I am sixth grade
1033 teacher at Sheridan Elementary School. I have lived
at 603 Oneida Street, Joliet, Illinois, for about 20 years,
1035 which is about five blocks from the Canal.
1034 Sheridan School is located about 3 blocks from
the canal on the west side. Shortly after school started
last September, 1939, the odor given off from the canal

1035 was very, very bad. Could smell it terribly in the school room. Children in my classes were very restless and it was hard to keep them at their work. I would say that loss of appetite and sleeplessness was the effect of the odor on me. Do not believe the odors in the years prior to 1939 were quite as offensive as during the last year or two. I noticed the odor at my home, but it isn't nearly so offensive as it is at the school.

1036 Can't say that conditions at school this year (1940) were as bad as they had been before, but it was a cool spring and a great many rains we felt must have taken care of it. Did not notice before the condition of restlessness among the school children. Of course the last two or three weeks of school in the spring the children are about ready to go.

1037 DR. COSMO MISICHIA. I have offices at 301 Cass street and reside at 516 Oakview Avenue, Joliet, Illinois. I have been practicing in Joliet since 1932.

1038 I have a patient by name of Mrs. Hope Fazio. She
1039 has been a patient for three years. A nervous type of woman, always complaining of headaches, nausea and what-not. Could never figure out what her trouble was. In her own words, every time there was a dirty stink coming from the Canal she was sick and couldn't eat. In my opinion the odor could create such a condition in Mrs. Fazio. They begin to smell the odor; they think about it and it upsets them. Like she complains, she is nauseated, gets a headache. I treated two of her children for the same condition. Couldn't find anything radically wrong with them—yet they
1040 were sick. The girl, 10 or 12, is off on a vacation

and the boy, 10, hasn't complained this year. The mother complained this year (1940). Last saw her about four weeks ago.

I have noticed an increase in impetigo amongst the children in last few years and a lot of pemphigus in the hospital. Have had one case after another. The babies come and in a day or two I begin to get complaints about big red sores and pus all over their bodies. I practice mostly among the Italians and most of them live in close proxomity to the canal.

1041 I did a lot of first aid or emergency for the con-
1042 tractor digging the deep waterway. Nearly all of them were infected and sometimes they went along two, three or four weeks before they cleared up. I imagine it was a staphylococcus infection—right in the wound.

1044 I had a patient by name of Felix Egizio—who was working on the canal. He had an infection of the finger. I treated him for a while but didn't get any results so I told him to go in to Chicago.

1045 The odor from the canal last summer, (1939) and this summer, (1940) I think is absolutely terrible at times. Personally have had some throat and ear trouble for last three months. I was treated by Dr. Len-
1046 non, eye, ear, nose and throat specialist. He said it was just a chronic inflammation. I went to Ontario on a vacation and third morning, my ear cracked open and throat cleared up and when I got back to Joliet I felt 100%. After being back a week or a little over my throat began to inflame again. Do not know whether
1047 or not the gaseous odors from the canal could produce such a condition. I think there is no question but

what the present condition of the canal constitutes a menace to the health of the city of Joliet, especially in the summertime. In Chicago when I was an interne we didn't see so much of these summer complaints as we see around here (Joliet).

1050 MRS. JAMES SAFFOLD. I am wife of the Minister of St. Mark's M.E. Church. I have lived in Joliet about 5 years; have resided at 348 South Joliet Street about 3 years, about 3 blocks from the canal.

I observed the odor from the canal last summer,
1051 (1939) and think it was more offensive than in past years. Effect was that I was nauseated, sick at my stomach that is all. Experienced sickness at my stomach before last year, (1939). Have noticed the odor this summer, (1940) but not as bad as last summer, (1939) which was the worst. Have lost no weight. Last time I weighed myself, my weight was 198 pounds.
1052 My general health is good.

1052 PETER LAVZZA. I have lived at 510 South Water
1053 Street for 27 years, located about 400 feet from the
1054 canal; work in the wire factory.

Odor from the canal was not so bad in 1938 but in 1939 it was awful and this year (1940) it is not so bad because they have cold spring and water. When the hot weather comes, the week before, we can't stand it any more. I feel sick right now. I didn't notice the odor last night, (July 23, 1940) because I worked last night. I was all in when I came home and couldn't smell anything because I was all in, I was
1055 half dead. The kids say the smell is awful. Family

visiting me complained of the odor. It is bad only in hot weather.

LEON GRIGGS. I have lived at 250 South Center Street, Joliet, for 16 years, about a block and a half from the canal. I have noticed the odor from the canal. I would say it was much worse in 1939. Noticed it a few nights in 1940 but not near so much. The odor disturbs our sleep. There are some nights we were hardly able to get to sleep. This was quite true in 1939—it was terribly bad in 1939. Just a few nights in 1940. That is the only way the odor has affected us. Present weight is about 195 lbs., height 5′8½″. I am a city fireman. I have been trying last few months to lose some weight.

BEN DEPRAT. I reside at 203 Sheridan Street, Joliet, Illinois, about a block from the canal.

I have noticed the odors from the Canal. It was worse in 1939. It hasn't been so bad this year, (1940). There have been some nights it has been pretty bad. Affects the youngest child most (aged 9). He won't eat half the time on account of the odor. In the winter and when it is cool he eats. Sometimes he won't even go to bed—says he smells that stink. It bothers my wife a lot and the rest of the family—keeps them from sleeping. It don't bother me after I fall asleep. Have no illness in my family now. My general health is all right.

MRS. EVELYN COLVON. I have resided at 108 DeKalb Street, Joliet, Illinois, going on three years—

1068 about a block and a half from the canal. Formerly lived at 507 Sherman Street, close to a mile from the canal. Moved to DeKalb Street in September 1938.

1066 There wasn't very much odor in 1938 when the weather wasn't hot, but last year, (1939) it was something terrible. This year (1940) it hasn't been so bad but we have had a few nights when it was terrible. This past Sunday night, (July 21, 1940) was awful bad.

I have been awfully nervous lately; have been to the doctor but he couldn't find anything wrong with me—only my nerves and that I needed more sleep; can't take time to lay down during the day when the odor isn't bad; it is mostly at night after the sun begins to go down. It bothers you terribly from then until

1067 10:30 or 11:00. You just sleep then from exhaustion. I weighed over 100 lbs. when I lived on Sherman Street. Now weigh only 95 lbs. Gain two or three pounds in winter and then in summer it is gone.

1069 MARY VIRGINIA KEIGHER. I have lived at 406 Oneida Street, Joliet, Illinois, since April 1940, about 3 blocks from the canal. Prior to that I lived at 1001 Western Avenue, 10 or 12 blocks from the canal.

1070 In the last year, (1939) I could notice the odor from canal four or five blocks but couldn't notice it out as far as I lived. I think it is just as bad every year. I walk across bridge every morning and there is quite

1071 an odor from it. Just after having eaten breakfast, it sort of makes you sick to your stomach. This year, (1940) I noticed it where I work, 163 North Joliet Street, more than I ever do at home. My health is all

1072 right. I am 18 years old.

1072 WILLARD G. BLOOD. I have lived at 312 Grove Street, Joliet, Illinois, four years, approximately 8 blocks from the waterway. I am a funeral director
1073 and my place of business is at 163 North Joliet Street, approximately 100 yards from canal.

I have noticed odor from canal the last two or three years. I would say that 1939 was much worse than 1938. This year, 1940, you can smell it just as much as last year, 1939. You get it mostly during
1074 warm weather. You can get an odor from it in cool weather, especially when wind is in the right direction. Personally it has not affected me to any great degree. It has made my family ill at different times. It is rather nauseating. My father has become nauseated on several occasions. I wouldn't say it has affected my sleep any. I operate a funeral business and I have to open the back doors to ventilate the building from
1075 front to back. In warm weather, I have to open the doors during the service or when they have a wake in the evening. We get a distinct odor of the river that people complain about.

1076 RICHARD J. COYNE. I have resided at 163 North Joliet St., Joliet, for 6½ years. The front of the build-
1077 ing is a block from the canal, the rear is half a block.

I noticed the odor in 1939, 1938 and 1940. I think 1939 was worse than 1938. At times in 1940 it has been as bad as in 1939. That is during the warm sea-
1078 son we have had. On the whole this year, (1940) has been cooler so far than last. The odor seems to be worse in the evening, eight o'clock on, and both my

wife and children complain of it. They complain of the odors and we shut the doors and windows, and then the children complain of the heat and ask to have the windows opened.

1079 I wake up most every morning during the warm weather with a brown taste or a bad taste in my mouth and the young fellows claim they don't want to eat any breakfast quite frequently. They seem to go on a hunger strike for a while and then you can't give them enough to eat. They eat very good for a week or so, but after a hot day and what we call a bad night, they have the same result over again—loss of appetite. My wife often takes very little in the morn-
1080 ing, saying she feels the effect of the condition around there. I do not think it bothers the sleeping of any of us unless it is getting to sleep. Once we get to sleep
1082 we sleep all right. The general health of my family is good. We have had the odor at intervals in earlier years, but not as consistent as last year (1939).

Thursday—July 25, 1940

1099 SISTER URSULINE. I have been Supervisor at
1100 St. Joseph's Hospital, Joliet, Illinois, since January, 1936. The hospital is located at 372 North Broadway and we have a nurses' home connected with the hos-
1101 pital which houses about 120 people. The hospital has about 220 beds. The hospital is located 1½ to 2
1102 blocks west of the canal. I have noticed at the hospital the odor from the canal. I thought the odor was more pronounced last year, (1939)—a disagreeable

odor The odor affects the sleep of the nurses and
1103 patients. The odor would have an effect on the efficiency of the staff if one doesn't get the proper sleep
1104 and one loses their appetite when the odor is so pronounced. The odor is more or less off and on—it is just general. The odor permeates the entire institution. It is more pronounced on the east side. It is my
1106 own observation that it is a gaseous odor and it really does nauseate you. It is very unpleasant and has an effect on your general condition. Patients in the hos-
1107 pital talk about it. Some days this year, (1940) the odor is very bad. Last week one morning it was very pronounced. On the whole this year (1940) so far it is about the same as last year (1939). Some days are worse than others. I didn't notice odors prior to
1108 1939; last year was more disagreeable. I noticed the odor in the early morning—it is strongest then.

1109 SISTER HILDA. I am librarian in charge of the records at St. Joseph's Hospital. I have been located at the hospital since 1920 and have been librarian for 10 years. I have observed the odors from the canal.
1110 Last year (1939) it was much more noticeable--very obnoxious. I know from nurses and visitors that patients all prefer rooms on the west side of the hospital rather than the east side because of the odor. My office is on the east side and I wish it was on the opposite. The odor affects my throat—it causes a rawness. St. Joseph's Hospital takes care of 5000 to 5500 in-patients and 800 to 1000 out-patients each
1111 year. Convalescent patients are not desirous to stay any longer than they have to and one of the prime

reasons is the bad odor they have to contend with, especially in the warm weather. Surgical patients on
1112 an average would stay 10 days and for the medical patients, the average would be 14 days. There have been numerous requests by patients to be going home
1113 before the normal period of hospitalization. The odor in 1939 was very bad in that section of the hospital used by ambulatory patients. I would say it wasn't
1114 even desirous to go out doors and take a walk because of the odor. The surgical supervisors have often stated to me they wished their operations were over on the
1115 west side of the house instead of the east side where they have to contend with that odor coming in regardless of whether their windows are closed. The
1116 odor does affect me. I can't sleep. I think this sum-
1117 mer, up to now (1940) is just about as bad as last summer (1939) and last summer was absolutely worse than the summer before.

1118 SISTER BURNETTE. I am a registered nurse and
1119 have been at St. Joseph's Hospital for the last 20 years. I am obstretrical supervisor, in charge of the maternity section located on the 4th floor of the hos-
1120 pital. The odor from the canal was very offensive last summer (1939). I think it was lots worse last summer than it had been previously. If it is very warm like it is now we try to give mothers in the birth room a little ventilation but we cannot do that—we have to close the windows, especially when a boat goes by, on account of the awfully offensive odor.
1121 The unpleasant smell has an effect on the expectant mothers. They cannot eat—they sometimes send the

tray back without even touching it. The birth room is on the east side toward the canal. The nursery where the newly born babies are kept, is on the west side. We have been forced to close the windows of
1122 the nursery on hot days because we don't want a new-born baby inhaling that bad odor. A new-born baby is susceptible to most anything—the skin and everything is more tender. They haven't got the resistence of grown people. I myself have had no difficulty sleeping; I am a pretty sound sleeper—but I
1123 haven't got my room on that side. My appetite is affected only if the odor is present. I think no one could eat then. Patients often ask to be transferred
1124 to opposite side. Can't say that the presence of the odor has retarded recovery in a maternity case.

1125 The odor is very bad at night, always. Sometimes I get up at two o'clock in the morning and cannot go outside with that stench. It is much worse when a boat is passing. I did not notice the odor last night (July 23, 1940) but did notice it the night before (July 22nd) about 10 to 11 o'clock. The odor is just as bad
1126- this year (1940) as it was last year (1939). Last year
1127 was worse than the years before. It is worse in the summertime but we have trouble in the wintertime too, it is better in the wintertime.

1128 SISTER HUBERTA. I am a teacher at St. Joseph's Hospital; have been there for eight years. I live at the Sisters' home. I notice, even during the night, that the gassy odor when it comes, affects my throat. I get coughing spells and have noticed the younger girls are similarly affected when speaking or reciting.

1129 Conditions last summer (1939) were very bad—but personally I cannot say that it was worse. It was bad enough and now, too, and I notice it more on rainy days when we have a storm and when large barges pass through stirring it up. We haven't had it so bad now for several days. My schoolroom is on the first floor, one side facing the canal. The odor permeates the school room and goes to the kitchen and all parts of the house. It is a suffocating smell—it
1130 chokes me. It affects my sleeping conditions.

I did not notice so much the effect on my appetite—but when it (the odor) comes, it disturbes my appetite before I even get in the dining room and makes me irritable. It gets on my nerves. July and August
1131 last year (1939) I think were about the worst. The odor has seemed bad just this past year. There always was a smell from the canal—not bad. There are two different odors—there is the decayed odor—it reminds me of rotten eggs—and there is some sharp gas that
1132 affects a person more. The annoyance I spoke of does not keep anybody from working—it passes off.

1133 SISTER HORTENSE. I am a nurse and anesthetist at St. Joseph's Hospital. I have been at the hospital since 1933.

There are many odors in the surgical rooms. The patients notice them when they come in. There is the
1134 disinfectant, anesthetics and of course the material being sterilized; but when we get the odor from the canal we can notice that a little stronger than the other odors. When the canal odor permeates surgery it makes me kind of groggy and affects my sinuses. I

can distinguish that from the anesthetics and other
1135 odors. During operations we have to keep windows closed in the operating room anyway. The big surgeries are on the west side and most of their ventilation is from the east side because we have to keep windows closed while we are working to keep out germs that come in through windows. When the odor is present the windows on the east side are closed too. The odor gets too strong. It is a sickening odor
1136 —I think it nauseates. The doctors and surgeons all sepak of it. I think the odor is stronger at night—about two to five in the morning it is terrible. This year when we have sunny days it isn't bad; on sultry
1137 days and after a rain, or during a rain storm, it is terrific—it is really very bad. About two nights ago
1138 I was up between two and three o'clock in the morning and really felt very sick from it that morning. It was Tuesday morning (July 23, 1940). I would say that the Sunday morning previous, about five o'clock,
1139 was bad. I think there is constantly an odor around two to five in the morning. I noticed it again in chapel
1140 this morning (July 25th) about four-thirty. I do not know that the odor wakes me up, but think it keeps me from going to sleep.

1141 SISTER PASCLINE. I am in charge of the office at St. Joseph's Hospital. I have been there since 1921. Have several times noticed a complaint on the part of patients with reference to a desire to leave the hospital early. Reason assigned for these complaints is on account of the stench from the river. They are nau-
1142 seated—their food doesn't taste good to them. After

a rain and that gas rises, it is very nauseating and I have had trouble for last year and a half with sick headaches due to stench from the river. It keeps me from working 3 or 4 hours at a time. It interferes very much with my sleep—especially after eleven o'clock or between two or three o'clock in the worning when
1143 the tug boat goes through and that sludge is stirred up, the odor is terrific. I sleep on that side and we are forced to close our windows. Last year (1939) the condition became severe after the amount of water was shut down. In 1938 there was some stench but not as much since as in 1939. The odor at our rising time, 4:30 in the morning to 6:30, is so severe it is almost impossible to stay in the chapel. When the wind is from this side (east) it is much worse but we smell
1144 it each time. The odor permeates the entire hospital —so much so that last Tuesday (July 23, 1940) we had to burn incense to have an agreeable odor when visitors came from the outside. This was about 4:30 in the morning and we could still smell it at tray time, 11:00 o'clock.

1145 SISTER DOLORITA. I am Supervisor of first floor of St. Joseph's Hospital, Joliet, Illinois, have been at the hospital for 8 years. I do not notice the odor from
1146 the canal so much on my floor as I do in the Chapel or when I go outside. It seems when I go up on the higher floors I notice it more than I do on the main
1147 floor. I notice it in the Sisters' Home too. It has no effect on me—I just don't like the smell of it. I haven't noticed it as much this summer (1940) as last summer (1939). We haven't had as much rain this sum-

mer as last and when it rains or when the barges go through is the only time I notice it.

1148 DR. RAYMOND J. KENNEDY. I have been practicing in Joliet since 1930. I recall treating a patient last year by name of Stephen Heinzel. I believe it was
1149 in April, 1939. Heinzel jumped in river and rescued an attempted suicide and I was later called to see Heinzel. At that time the only injury I could see was a superficial laceration around his ankle. I cleaned the wound out with an antiseptic—a solution of myrtillin
1150 and a tincture of methylate—washed the wound with a little boric acid and some argyrol. I noticed a change in the condition of the laceration about the third day. He started showing a little infection—a little redness around the laceration with the production of a little superficial pus. Within the next day or so he started developing a spread of this superficial infection and it developed into what they term a cellulitis of the leg, which is an infection of the skin and underlying tissues. I have no opinion as to what type of germ produced the infection—no cultures were taken. The usual measures of hot packs and antiseptics were used and it did clear up. It took approximately 10 to 11 days
1151 before it was entirely healed. Heinzel sustained the wound in the water and I believe it may have had something to do with it.

1153 SISTER MELITTA. I have charge of the third floor of St. Joseph's Hospital, Joliet, Illinois. I have been at the hospital 20 years. The patients on the east side of the house do complain about the odor from the

canal. It does not have so much effect on their sleeping conditions as it does on their appetites. They say the odor is so terrific they just can't eat. I can't
1154 say that conditions last summer (1939) were any different than thay have been in the past, but I know that every time the boats go through it is worse and whenever it rains it is worse; when the water is quiet it is not so bad. I can't say that I have ever had any requests from patients to either leave the hospital or move because of the odor. The odor affects me only early in the morning—it is most offensive in the morning. I think the odor is mostly intermittent. I sleep
1155 too good to notice it at night while sleeping. It has no effect on my appetite.

1155 SISTER IRMENGARD. I am Surgical Supervisor in the operating room at St. Joseph's Hospital. I have been at the hospital since 1922 and have been Surgical
1156 Supervisor about eleven years.

I have noticed an odor from the canal. Think the odor was more intense last summer (1939) than I ever noticed before. In my work in surgery I have
1157 noticed the odor from the canal very much. We keep windows in operating room proper closed and get our ventilation from the east side of the house. If we don't close the windows and doors on the east side we can hardly stand it at times in the operating department. It is a nauseating odor—you just get sick to your stomach. We get used to the odors in the operating room but I cannot get used to the odors from
1158 the canal. Aside from my work in surgery I notice the odor at times, especially early in the morning

in the chapel. When I first get up I have a depressed feeling certain mornings—it isn't every morning. Do not think I could say that the odor has had any effect on my apeptite. Conditions this year (1940) have, for some reason, not been as bad as they were last year (1939). I thought it was because the heat had not been so intense and not so much rain. Have not noticed odor in surgery as much this summer (1940).

1159 SISTER PETRONIA. I am a substitute teacher—
1160 I go out and help on the different missions. Have been living at St. Joseph's for the past two years. Have noticed an effect on myself of the odor from the canal. I have been bothered with sinus trouble quite a bit since May, 1938. At times, the fall of 1939, I had to have treatments twice a day for a period of over a week before I could get any relief, and from then on whenever the odor is strong, I have that congested feeling in the sinus region. The difficulty in my sinus is present especially when the odor is strong. Notice the odor most of the time early in the morning, say
1161 around four thirty, five o'clock. Lately it has been quite a bit in the evening around eight or nine o'clock. It affects my sleep somewhat. I had a very slight touch of the sinus trouble about six years ago. I took treatments at LaSalle, Illinois, and it was entirely cleared up. Since I am back in Joliet the attacks came back in a more extensive degree. I had no treatments for it in 1940.

1162 MRS. JOHN JEFFREY. I have resided at 211 Western Ave., Joliet, Illinois, for 17 years—100 feet

from Cass Street bridge on the west side of the canal. I have observed the odor emanating from the canal.
1164 The odors were terrible last summer (1939). Due to the cool weather we had the first part of this summer (1940) I do not think it has been so bad. It wakes me out of a sound sleep at night. Tuesday morning (July 23, 1940) and last Friday, Saturday and Sunday, (July 19, 20 and 21, 1940) it awakened me out of a sound sleep. It makes me kind of sick—just gags me—I can't get my breath. I have had trouble with my nose—it stuffs up—I just can't breathe out of my nose
1165 —I have to be spitting, that is the whole thing. I have been suffering with that since the summer of 1939 and blame it on the odor of that river. The time of day when I notice the odor especially is when a big barge goes through and stirs up that water but it is terrible in the morning from about two o'clock on.
1166 I have been confined to my bed lots of times lately. Last time I weighed I had lost ten pounds, between last winter, early in the spring of this year (1940)
1167 up to now. I am sick to my stomach practically all the time—can't eat the way I should. Last time I
1168 weighed I weighed 149. I do not know my height exactly—a little over five foot. We live in an apartment; just rent. I never noticed the odor so much as I did in 1939 and up to the present time. I could not say that there was an odor before 1939—not as
1169 bad as it is now, I never noticed it much. I am under the doctor's care now for different ailments.

1170 MRS. STELLA LOGAN. I have lived at 408 North Bluff Street, Joliet, Illinois, for the last six years. Live

about 100 feet from canal. Have five children. I have noticed very much at my home the odor given off from the waterway. It does not have so much effect on me as I am not quite so nervous. My oldest daughter had headaches and nauseated stomach all the time. She will not play outside—would rather stay in the house. Suffers from these headaches just in the summertime. Last year (1939) the odor was much more
1171 offensive than it had been in the past. This year is not quite as much because we had it cool—and it seems that may be there is more water going through, but it is terrible when the barges go through. I think
1172 there are more boats going through this year (1940) and that kind of takes the scum away. The oldest girl has become nauseated from the odor and has vomited. The odor does not seem to affect the other children. The odor generally wakes me up early in the morning before five o'clock.

1174 STUART BEEBE. I have lived at 24 North Bluff Street, Joliet, Illinois, for 6 years—on the west side about 15 feet from the river.

1175 I noticed plenty of change in the condition of the river last year (1939) from the years before that. There was a lot more scum on the river and an odor coming from it. I believe I lost my appetite from that odor. It does not affect me so much in the winter.
1176 Where I am I really don't get a lot of odor except when a boat goes through because it seems to come up and go over the house. When the boats go through I get plenty of it. It has not affected my sleeping.
1177 I do not think the odor this year (1940) is quite as

bad as last year (1939) There has always been some odor on the river during the time I have stayed at this address. Notice the odor this year (1940) when
1178 the boats go through, and it is very offensive to me.
1179 In the wintertime I have a very good appetite and in the summertime, around June or July I will have a cup of coffee for breakfast—one sandwich for dinner and may be a potato and pork chops for supper. I am 40 years of age, 5'10" in height and weigh about 152 lbs. I am employed and worked regularly up until this week when I was laid off on account of no work in the shop right now.

1180 SISTER MARY JOVITA. I am a nurse at St. Joseph's Hospital. Have been there almost 30 years. I have noticed plenty of odor from the canal. I think in 1939 it was more severe than ever before. The patients complain of nausea and vomiting and espe-
1181 cially during the night. Sometimes I have to put cotton in the patient's nose. When the patients are very sick and have stomach ailments and they are vomiting all night they have no appetite the next day, and then maybe the following night it is the same thing. Some patients won't stay long in the hospital, and before they remove the stitches after the operation, the patients go home. They tell me it is due to the
1182 odor of the canal. They have the stitches removed at home. I have noticed an effect of the odor on the sleeping or resting of the patients. I have noticed this effect on several patients who are very ill and have a poor delicate stomach. Even the other day when I made my rounds a patient had nausea all night. I

asked the cause and the patient said "due to the smell of that odor".

1183 The odor bothers my own sleeping quite a bit when the wind goes over from east to west. At times it also gives me headaches and nausea. I notice the odor most early in the morning. At the Convent we get up at 3:30 in the morning and it is awful. Sometimes when we get up for surgery at nights then it is
1184 just terrible—a very offensive odor. I think last year (1939) was worse than this year (1940).

1184 MRS. GERTRUDE HARPER. I have lived for a little over 2 years at 26 North Broadway, Joliet, Ill., about 200 feet from the river.

1185 I notice the odor from the canal. Since I have been living at this address I find I have developed a sort of sinus trouble and my throat seems to have a raw feeling in it. I had to go to a throat specialist and have my throat swabbed with a medicine and I have had my sinuses drained. I think about four or five times since I have had that condition. I did not have this throat condition until about two years ago and then I noticed it mostly in the spring weather. Last year (1939) the odor was terrible. I took a cottage out at
1186 Troy in order to sleep. At times I am nauseated
1187 when I smell it. This year (1940) it seems to me, conditions would be a little better. It seems like the boats are still stirring it up. It is just on certain times, like may be in the morning around two until a little later on in the day, if the boats stir it up and the wind is in our direction than we get that odor. My husband is a great big guy and shouldn't be affected.

He got up several mornings and he was very nau-
1188 seated. My health was bad before I ever came to Joliet and I went on a special diet to get fat on my body. My sinus trouble began about two years ago when we moved to Joliet from Evanston, Illinois.

1188 SISTER EVANGELISTEN. I am a nurse at St.
1189 Joseph's Hospital now but wasn't for the last ten years—I was there previous to that.

I have observed the effect of the odor from the canal upon patients under my care. Patients that come in with a delicate stomach, or a sickness causing nausea, are more nauseated from the odor and due to that nausea they are unable to eat and unable to sleep. It retards recovery of a patient because the patient is not able to take the prescribed nourishment they are supposed to take. If they are recuperating or if
1190 they have just come into the hospital the odor prolongs their illness, I should say, many times. I would not say that every patient is affected because some patients might not be as susceptible to that. I am certain that certain patients, like post-operatives, are affected much more because the post-operative patient has an upset stomach and the odor naturally would make it worse. I think the odor last year (1939) was very bad. At times before we got a rain, or depending on the direction of the wind, the odor was very bad all during the nights. I noticed the odor being
1191 very strong—especially like the night before last (July 23, 1940). Two boats went through and I noticed how bad the odor was. It seems when the water is in motion that it is worse. The odor very often has

an effect on me personally. If I am not feeling so good and kind of nauseated, and if that odor comes up during the night it makes me more nauseated. This
1192 year (1940) it is just lately I noticed the odor. I think it is due to the heat. Since the heat I think the odor this year is quite severe. The odor is worse at times. I think at nights and some days when the wind comes from the right direction and before we get a
1193 rain it seems to be worse. I first came to Joliet in 1910 and whenever there was an odor we would say "It is the old dirty canal". That was quite some time ago.

1193 MARY ELIZABETH MOMPER. I have lived all
1194 my life at 254 North Center Street, Joliet, Illinois, on the west side of the canal. I am a private duty nurse and have worked at St. Joseph's Hospital a great deal
1195 of the time. I have observed the condition of patients when subjected to the odor from the canal. I was out of town from May to August of last summer (1939) but when I came home in August I found the odor terrific. The effect of the odor on the patient is nauseating and causes restlessness. Sometimes if the odor is bad around meal time they can't eat and if they do eat they are not able to retain their food. They become restless if they are nauseated and they can't sleep.
1196 The effect on me personally is to make me nauseated if I am very tired. I try to plug along when I am on duty but it isn't very comfortable. I have heard patients complain that they wanted to leave the hospital but haven't had any come directly under my care. This year (1940) before storms and if a boat happens

to go up or down the river I think it is more pronounced then. Depends on how we get the wind. I do not think it is quite as bad this year (1940) as last year (1939). My home is four blocks from the
1197 canal and I have noticed the odor at home. It bothers my mother a great deal but the rest of us seem to be able to take it fairly well.

1197 SISTER EMMA LOUISE. I am an anasthetist at
1198 St. Joseph's Hospital. I have been there seven years steady. I observed the odors from the canal last year (1939). Between two and three in the morning when it was rather sultry and after raining or during a rain it was terrible. It was very offensive and made me very dizzy, sickening. Think I would become accustomed to the odors in surgery—they never bother me
1199 like this (the canal) odor did. It was very nauseating and really would bring a sort of faint feeling upon a person. If it come out between two and three in the morning or so there was no use to try to get any sleep after that. I think, more or less, there has always been an odor there. It always seems the same to me. At times it seemed worse but the last week or so I don't think it has been as bad as it had been. There have been only two mornings that I noticed it had been somewhat offensive. It interferes with my
1200 own sleep. Patients have complained about losing
1202 sleep on account of that odor. Patients are not allowed to go home without the permission of the doctor.

1203 SISTER ALMA JOSEPH. I work in the x-ray department at St. Joseph's Hospital. I have been there eleven years. I have observed the odor from the waterway and it was considerably more offensive last summer (1939) in warmer weather than it had been in prior years. Patients for the x-ray or fracture patients all complain about the odor disturbing their sleep at night and also making them nauseated and
1204 they can't eat or if they do eat they are distressed. Noticed an increase in this type of complaint during the hot weather in 1939. The odor makes me nauseated and I can't eat and I am weakened and it does retard and hinder my work in some respect. I can't think right then. I am a good sleeper and I couldn't say I notice it at night—I have smelled it at night.
1205 I think the odor has an effect on the nervous condition of the patient. They are nauseated and not being able to eat they become nervous and irritable. That effect when the odor is perceptible is quite general —those that aren't affected are the exceptions to the rule.

1206 We haven't had enough hot weather this year (1940) to notice it much. It was early in the morning about a week ago I noticed the odor offensively at the hospital—it was very bad. Do not recall how long it lasted but it must have been several hours.

1207 SISTER CLEOPHA. I am a laboratory technician
1208 at St. Joseph's Hospital. I have been at the hospital for ten years. I certainly have noticed the odor from the hospital. The odor has been very offensive to me all along. I often have to leave my work on account of

headaches and nausea. I simply cannot work any longer; I have to go off duty. I experience that feeling when I smell the odor. I don't feel that way at other times. I have noticed the odor this year (1940) but not so much as last year. I had to lay off work once this year (1940) for two or three days and last year I would be off for a few days and then go back to work. I couldn't say definitely how much, but it was quite a bit. I am somewhat of a nervous disposition.

SISTER MARY GEORGE. I am a nurse at St. Joseph's Hospital and have been there six summers. The odor from the canal was quite considerably more offensive last summer (1939) than previously. I think the odor has a particular effect on patients—a great many will complain about it when it is present. It will many times have a more serious effect on a new surgical patient than a patient that is perhaps progressed more along his way to recovery. The patient will become nauseated or if he is already nauseated it doesn't help his condition any; other patients, if it is around meal time, it seems to interfer with their eating. If patients are on that side of the building it is more noticeable—it makes them uncomfortable and of course that will interfere with their sleep. If I have worked quite hard all day and then the odor comes up at night it is very disagreeable to me. I am a pretty good sleeper once I get there, but it doesn't help any as far as eating is concerned. I notice the odor most during the real hot weather such as we have had the last couple of days and particularly when the boats

go by. Conditions this year (1940) do not seem to be quite as bad as last year (1939). They are bad enough.

1215 LEONA PETERSON. I have lived for two years at 263 North Chicago Street, Joliet, Illinois—about 4 blocks from the canal. Before that I lived in Chicago. I noticed the odor from the canal last summer (1939) 1216 —it was very bad last summer—more so than this summer. The odor is terrible. It caused my children to wake out of a sound sleep and complain. They weren't hungry because of the odor—it just seemed to take their appetite. The odor did not especially affect me—at times it did affect my sleep. I cannot say that the children suffered any illness when the odor was present. No nausea was induced by the odor. I noticed the odor around in July and August (1939) when it rained or was sultry. There have been times when it hasn't been so pronounced. I have noticed it this summer (1940) but it hasn't been quite as bad as last summer—(1939).

1217 PETER BECK. I have lived for 30-40 years at 1218 511 West Jasper St., Joliet, Illinois—about 2000 feet from the canal. Last year (1939) the canal had a scum on it that thick (indicating) at the lower end but it isn't there so much this year (1940). The odor last year (1939) was bad. The odor got me a lot of times 1219 that I couldn't breathe. The odor affects the other 1220 members of my family. The effect on me is a gag- 1221 ging or choking. A lot of times we couldn't sleep on acount of the stink—not smell. It has been better this 1222 year (1940). I did get a whiff of it night before last

(July 23, 1940) but not as bad as we used to get it. I used to get a couple of these 35c jugs of beer and drink them so I could fall asleep and wouldn't smell
1223 it. I weigh 217 pounds and think I am about 5'11" tall. I am 66 years old. I am in good health.

1224 MRS. SOPHIE SEEBER. I have lived for five years at 263 North Chicago Street, Joliet, Illinois, three or four blocks from the canal. There surely was an odor from the canal last summer (1939). It was pretty bad last summer. I thought it affected my daughter
1225 more. She (the daughter) couldn't stand it. She always complained so much about it. She had so many headaches all the time—she couldn't go to sleep. She said the smell made her head hurt her so. It didn't bother me much. It affected my daughter's appetite —she couldn't eat. Conditions this year (1940) I think are not as bad as they were last year (1939). Once in a while evenings this year we get it pretty strong.
1226 The smell doesn't just make me sick but it bothers me. I don't know whether I am overweight—haven't weighed in a long time.

1227 MRS. LOUIS DATOZECH. I have lived for 18 years at 5 North Broadway, Joliet, Illinois. I noticed very much the odor from the canal last summer (1939). Since we have lived there there has always been a slight odor, but never like it was last year. This year I don't think it has had a fair chance up to now because the weather has been cool, except that last week.
1228 The odor is terrible hard to sleep, makes me groggy like, children complain of the odors. Did not notice

odor much before last summer, now it has got to be a nuisance.

This year (1940) you can smell it at times, mostly in the morning or if a boat goes through—but outside of that it isn't bad except on a real sultry day—then you get it any time of the day. It was when it was real hot last summer (1939) that the bad periods set in. Everybody in their immediate neighborhood I talked with noticed it. I am somewhat overweight.

MRS. ANNA ELFDER. I have lived for 25 years at 120 New York Street, Joliet, Illinois, maybe 50 feet from the waterway. I was in Europe last summer. This summer (1940) the odor from the canal smelled terrible.

MRS. RAY ALTENHOFF. I have lived for eight years at 13 North Broadway, Joliet, Ill., about a block and a half from the canal on the west side. I noticed that the odor from the canal last summer (1939) was much worse than it had been previous to that time. The odor was very offensive to me. Outside of making me nauseated it didn't affect my general health. That happened whenever it was a dark sultry day when the air was heavy. The odor had no other effect on my general health. It affected my sleep if I awoke in the night and the odor was there. It generally is at night more so, it seems, than during the day. It did not affect my child in any way. There has been a noticeable decrease in my husband's appetite. I would say he had nausea as a result of it. When I noticed the odor there was general complaint throughout the neighborhood.

I have not noticed the odor so much to date this year (1940) because we have had a cold spring and summer except for a couple of days. Lately the last few days it has been very noticeable at night.

1239 FRANCES LOW. I live with my parents, sister and grandfather at 12 North Broadway, Joliet, Illinois. We have lived at that address about 20 years. We noticed the odor from the canal last summer (1939) more than in the years before. It affects me at night. On waking
1240 in the morning you have an awful groggy feeling and lots of time I have awakened with headaches. When I wake up in the middle of the night I can't go back to sleep. When I notice the smell I can't eat—it makes me
1241 sick to my stomach. My grandfather is ill when the odor is present. He has heart trouble and often complains of lack of sleep at night. He always wants the windows closed to keep out the odor. The odor makes him short-breathed and when it is at its great height he becomes ill and practically has to go to bed—he can't stay up. Last summer (1939) we noticed the odor more in the evening than we did in the day. It was the early part of July I think when we first noticed it a great deal. That was when it became particularly offensive and it lasted three months anyway—the whole sum-
1243 mer. July and August was when it was at its greatest. Noticed it in that hot spell in September—it was very bad then too. Noticed it in May and June but it
1244 was not as bad. This year (1940) I don't think it is bad because of the cold weather we have had. My grand-
1245 father is 81. He has heart trouble—for about the last two or three years.

MRS. MELLISON RENGER. I have lived for 12 years at 9 North Broadway, Joliet, Illinois. It is about 2 blocks from the waterway.

I have noticed the odor from the canal. I can neither eat or sleep. Whenever I smell that odor my stomach is all upset—I get nauseated. I never get a headache from it. I never sleep except when the odor isn't there. The last two weeks I haven't slept very much. It has been pretty bad. I noticed the odor last night (July 24th). It was so bad I had to go out on the porch at one time at one o'clock. The odor was something terrible. The odor last summer (1939) was quite a bit worse than in the years before. I am 76 years old and have lived alongside the canal about 30 years. My health is pretty good.

HELEN CHRZANOWSKI. I live with my father at 317 North Chicago Street, Joliet. We have lived in the same location for 18 years—about a block and a half west of the waterway. The odor from the canal in 1939 was so bad we could hardly stand it in our neighborhood—an offensive odor. It has been that way as soon as it gets warm until it gets cold—around December. It seems to be about the same this year (1940) as last (1939). I believe I am overweight. I myself have noticed the odor ever since we lived there—18 years.

MRS. JOHN CONLEN. I live with my husband and two daughters at 112 Broadway, Joliet, Illinois. We have lived at this address only about 4 months. Prior to that we lived near the West Pine Street Canal on Pine Street for 8 years; lived at the Pine Street address in

1264 1938 and 1939. I think the odor from the canal in 1939 was worse than it has been this year. I think conditions in 1938 were about the same as in 1939. First noticed it in 1939 in the hot weather—July, August and September. We can't sleep at night when it is real bad; it gives you a bad taste in your mouth and throat and
1265 headache—that is about the worst affects it has. The odor this past week has been pretty bad. Prior to the past week there was another bad spell, six weeks or a couple of months ago.

1265 JAMES BONAKES. I have lived at 210 Bluff Street,
1266 Joliet, for four years but have lived on the same street for 30 years. Before 1939 we did not smell the odor from the canal so much, but in 1939 it was very
1267 bad. This year (1940) I didn't notice it very much. The worst year was 1939. Noticed in June and July, 1939—when the river was thick. I was in good health in 1939. I have lost 30 pounds but didn't lose it on account
1268 of the water. Odor in 1939 affected my sleep. I do not eat very much. This year (1940) I don't feel the odor as
1269 much as I did in 1939. My age is 56. I have high blood pressure and kidney trouble.

1272 JAMES ARGONDALIS. I operate a bakery down on Jefferson Street about half a block from the waterway.
1273 Have been in business there for 20 years. I have lived at 2 South Broadway for 6 years—half a block west of the river. Just lost my wife. Have two children, 9 and 10. In the summer of 1939 the odor from the canal was bad enough that you couldn't sleep. I came home at night and took the kids and the Mrs. to the park—lived

there practically all summer and slept there. This was because the smell was so bad we couldn't stand it. At the bakery in 1939, everybody that came into the store complained the smell was something awful. It started the first hot weather in July and ended, I guess, sometime in October. During 1939 my wife was sick and I had to move her to a friend of mine in Chicago. She died of cancer. It has a dizzy effect on me. At times it smelled so bad I couldn't eat. My sister whom I hadn't seen for ten years came July 15, 1939 to live with me during vacation. She left the second week because of the smell. Last year (1939) was one of the toughest years I can remember on Jefferson Street—the smell was very bad. It affected my sales; had less customers 1939 was the worst year. This year (1940) we didn't have hot weather yet; this is first hot weather we have had, two or three days; can smell it very light. Business this year is better than in 1939. My weight is 205 lbs.; I am 5' 11" tall and my general health so far is good.

PETER IMFELD. I am 66 years of age, have lived for 25 years at 542 North Bluff Street, Joliet, Illinois—about 120 feet from the waterway. In May and June of this year the water wasn't hardly moving and when a boat came up I would get an odor, especially with an east wind; otherwise, it didn't affect us there. In 1939 when the east wind came that is the only time we would get it. It had no affect on me or on the other members of my family—except the odor once in a while would get a little strong smell. Monday morning this week about three o'clock when the boat came down there was a pretty good smell of it.

ROSA DOWNEY. I have lived at 356 North Bluff Street, Joliet, Illinois, about 2 years and 3 months. We live on the east side of Bluff Street and our lot runs back to the canal. The odor from the canal seemed that year (1939) than it does now (1940). This year by spells it bothers just as bad. It affects my daughter quite a bit. It makes her sick, especially if a boat goes up while she is eating. She just gets up and leaves the table. That has happened half a dozen or more times this year. I am 60 years old and my health is good but my daughter's isn't.

DR. GEORGE E. ROONEY. I reside at 753 Buell Avenue, Joliet, Illinois. I have been located in Joliet for two years. I came to Joliet from Chicago in April 1938. It was extremely hard for me to acclimate myself to the odor from the canal. There were some nights it would be almost impossible to sleep. At that time I lived on the southwest side near Brandon Lock. Since that time I have been on the northwest side and I don't get the odors quite as bad. My office is in the Joliet Building at 4 East Clinton Street. There were some days in 1939 when the odors were observed in my office. I have many times observed the odor during the exercise of my professional duties at St. Joseph's Hospital. In 1939 I observed these odors daily during the summer. I believe the odors were about the same in 1938 and 1939. I think my nasal apparatus has gotten used to the odor and I don't mind it quite as bad in 1940.

In 1939 I had patients with nervous diseases, to which I ascribed these odors as a factor in the cause

and effect relationship of the condition. I had one patient it was necessary to send to Manteno State Hospital for the Insane; she had the idea everything that came into the house carried the odor of the canal and she on several occasions thought it was definitely due to the odors that had arisen from the canal. This woman complained severely about the smell. My diagnosis of her condition was that she was having hallucinations of a nasal or scent character. The odor from the canal was an incidental cause in producing the condition she had. She lived at 108 DeKalb Street which is within two blocks of the canal. She was 54 or 55. I had another patient, a woman suffering from mental disturbance. I put her in St. Joseph's Hospital for treatment. The minute she started to feel better she complained the odors were so great she didn't want to stay there any longer. She left to go to friends in Lockport and from Lockport she was on the train to go to Kansas City and she expired on the way. That of course is incidental in the case. She was a patient at St. Joseph's 26 or 27 days. That was in 1940—this year—and at the time I attended her, odors were observed by me at the hospital. The odors produced the affect of her leaving the hospital at too early a date.

I believe the odors have tended to retard the recovery of patients at St. Joseph's Hospital. People who come to the hospital, and live several miles from the canal usually ask to leave, because of the odors, sometimes before they should. In many cases the odors are a causative factor in loss of sleep and also in some of my cases, of headaches. There is the possibility that due to loss of sleep and the continued smelling

of these obnoxious odors over a long period, it might
1296 give people a rather weakened nervous system. The people I have observed complaining about these odors are chiefly the people who have been hospitalized in St. Joseph's.

1298 MRS. JESSE O'DANIEL. I have lived for 5 months at 510 No. Bluff St., Joliet, Illinois—about 100 feet from
1299 the canal and before that I lived on a farm in the country about a half mile from the canal. I have noticed an odor from the canal 10 or 12 times this year. (1940). I have two children aged 12 and 14 and the odor affects my daughter's appetite and sleeping. She is a
1300 nervous child; she just can't eat. When there is an odor it affects my daughter sleeping more than it does her appetite. As for myself, it affects me too—I wake up out of a sound sleep and it is worse when the boats go by.

1301 J. G. NICHOLS. I live at 611 Third Avenue, Joliet, Illinois, about a mile from the canal. I have observed the odors from the canal very often at my home; near-
1302 ly every night last summer (1939) if the wind was in the right direction. This year (1940) we haven't had so much hot weather and it was just last week I noticed it. I myself am rather immune to such things but it affects my wife—nauseates her—causes loss of sleep—loss of appetite and makes her throw up at night. That has not happened this year (1940). She hasn't been as bad as she was last summer—(1939). I think it was account of the heat.

1303 CATHERINE KOEHL. I am a nurse at St. Joseph's Hospital; have been there three years. My home is at 519 Walsh Street, Joliet, Illinois. I have lived there all
1304 my life. The odor from the canal was worse last summer (1939) than it had been in previous years. Inhalation of the odor had an effect upon patients under my personal care—they wouldn't eat and they couldn't sleep at night. I usually have five patients and when
1305 the odor was present it affected most of them. As to myself I sleep on the porch in the nurses' home and it is very hard to sleep when the odor is up. I have had patients under my care request to be moved somewhere where there is no odor. I have had patients under my care taken home before sutures were removed because they couldn't stand the smell of the river. These sutures were removed at the home of the patient. I have known
1306 that to happen several times. I noticed no effect of the odor on newly born babies. It caused loss of sleep and loss of appetite to other nurses. The odor this year
1307 (1940) has been as offensive as it was in 1939. I have noticed that when a patient complained about the odor there was a rise in temperature. I have had a patient under my care become nauseated and vomit as a result of the odor. These odors have caused a rise of temperature of one or two degrees. Before the odor was complained of the patients temperature was usually
1308 down, but after they complained of the odor it was always up. That was invariably the case. My own health is fine.

1309 ROSE VELT. I am a graduate nurse employed at St. Joseph's Hospital; have been there three years. The

odor from the canal in the summer of 1939 was more intense and offensive than it had been in previous years. The effect of the odor on patients under my care has been loss of appetite, restlessness and inability to sleep. My observation as to inability to sleep was made during the times I was on night duty. I myself have noticed the effect of the odor in my sleeping. I have had no patients under my care ask to be moved to different parts of the hospital when the odor is present. I think the odor has been worse this year (1940) than last year (1939).

HELEN HIMES. I am a graduate nurse employed at St. Joseph's Hospital. I trained there for three years and have just graduated. I noticed at the hospital in 1939 an odor from the canal. It seems to be worse this year (1940) than it was last year (1939). First noticed it this year about a month ago during those few hot days and then after a rain it always smells. I have had several—5 or 6—patients under my care complain about the odor. Usually a very sick patient has no appetite on those hot days when it smells like that—and then at night, of course, they don't sleep either. It bothers me personally—I can't sleep at night. It wakes me up. After a rain the odor usually lasts about a day—a very bad odor. There always is an odor continuously. I have noticed the odor during all the time I have been at the hospital. It is bad only after a rain or during real hot weather.

Thursday, July 25, 1940

ELIZABETH BAUTINO. I am a graduate nurse, employed at St. Joseph's Hospital. I have been there for three years. I believe the odors from the canal were worse in 1939 than in 1938. I have not noticed any effect on patients other than those mentioned by the other witnesses—restlessness and inability to sleep and loss of appetite. The effect on me personally was to keep me awake several nights—in fact most of the time. I do not think it had any effect on my appetite. I have observed a patient become nauseated as a result of the inhalation of the odor. I have noticed it an hour or so after meals, especially in the afternoons all through my training, but believe more last year (1939). So far I think the odor in 1940 is just as bad as in 1939.

DR. DONALD BOLES. I am an interne at St. Joseph's Hospital. I have been at St. Josephs since June 1940 and was an externe there last summer (1939) for seven weeks from June 10th to August 2d. While there in 1939 I observed offensive odors from the canal. It was an unpleasant, nauseating, dirty odor. It smells like fecal matter that is left in the sun to ferment or partly oxidize. The principal complaints from patients were if they were located in a room on the east side of the hospital the odor annoyed them when they tried to sleep at night, or if the odor should come up at meal time they couldn't eat their meals. I have had requests to transfer patients (from east side) to the opposite side of the hall. This was not an infrequent experience—nor was the request from every patient

1321 either. When the weather was cool I didn't notice the odor so much, but when it warmed up, and when 1939 is compared with 1940 day for day with equal temperatures and other atmospheric conditions being the same, I would say that a like day in 1940 would be much worse than in 1939. During July 1940, since it has become warm, I have been bothered personally. The window in my room opens to the east and at different times, if the odor should come up, I have had
1322 difficulty going to sleep. Last night (July 24, 1940) about 7:30 in the evening I went out on the porch and felt rather nauseated because of the odor. Later on in the evening I couldn't smell the odor. I have lived in Joliet all my life and was home the whole summer of 1938. Comparing the odor in 1939 with that in 1938 I would say that 1939 was the first time the odor ever
1323 annoyed me. In 1938 we had very slight odors after or before a rain. In 1939 the odors were present in much greater density. They were never nauseating before 1938. I cannot observe the odor in the delivery room because the windows are kept shut. We keep the windows shut because the odor would nauseate the pa-
1324 tients and probably the attending personnel also. Before becoming connected with the hospital I lived only
1326 three blocks from the canal on the east bank. My personal experience has been that the odor came up more between the hours of five to nine in the morning than any other hours of the day.

Thursday, July 25, 1940

1326 LORETTA HOLLIS. I am a graduate nurse employed at St. Joseph's Hospital for the past three years. I observed offensive, unpleasant odors from the canal in 1939 throughout the summer months—it usually
1327 started around the last of June. It is hard to describe the odor but it was terrific—very offensive. I observed
1328 that my own patients could not eat when a good whiff of that came along—it was very nauseating and irritating to the patients. I have had that experience quite often during the summer months of 1939. I was also on night duty and observed during 1939 it was very hard for patients to sleep during the night due to the odor. I observed nausea, vomiting, insomnia and ner-
1329 vousness. That was quite a common experience. I cannot say that conditions on hot days in 1940 are any better than they were during the summer of 1939. 1939 was about the worst we ever had. 1939 was worse
1330 than 1938 which was bad enough. I observed the odor in the obstetrical department but we kept the windows closed because so many of the mothers would complain of the terrific odor. I personally heard these complaints in 1939—it was quite frequently. I know of cases where patients after operative treatment have asked to leave the hospital before their hospitalization was finished. They said they would rather go some-
1331 where else than to lie in their room and put up with that odor. In 1939 I know of some post-operative patients who have had sutures removed at home. I know of none so far in 1940. The odors come and go, es-
1332 pecially during or after a rain—it is terrific then. I

have tried bringing the tray back to a patient after the odor has passed away, but due to nausea they would rather wait until the next meal time. I have tried this more than once but never succeeded. The odor has not had much effect on me lately, but in 1939 I have given up many a meal due to that fact. It is a fact that I lost some weight. I am not a whole lot overweight.
1333 The hot weather affects the sleeping of patients to a certain extent.

1334 EDWARD OISELLE. I have lived at 509 West Jas-
1335 per St., Joliet, Ill., approximately three years—500 to 600 feet from the canal. My family consists of my wife and two children. I think from my observations the odor in 1939 is the worst year of them all. Looking at the canal coming downtown this afternoon (July 25, 1940) I was almost ashamed to come up here—it looked pretty nice. The odor in 1939 caused me to tear up the
1336 whole basement floor looking for a dead rat which wasn't there. I haven't noticed the odor much this year (1940), but last year (1939) when the sludge was on there it was practically unbearable at times, especially in hot weather. So far as causing any ill effects I haven't noticed any in my family, but you can't sleep because the odor is offensive and it feels like your food
1337 is tainted. Of course when they empty that thing up at Lockport and let the stuff come down the canal it is very bad then. The temperature today (July 25, 1940) must be around 101.

Thursday, July 25, 1940

JOHN VOLGAR, I have lived for 25 years at 233 Bluff Street, Joliet, Ill.—about 100-130 ft. from the canal. I noticed the smell not so much in 1938. I smell it at night time—the big boats mix the water—the smell is terrible. Last year (1939) the smell was worse than this year (1940). I have had headache trouble all the time from the smell. It bothers my wife and children too.

JANET HEGGIE. I am a graduate nurse at St. Joseph's Hospital. During the spring and summer months of 1940 the odor was terrific and I have noticed patients were greatly affected by it. They were nauseated and couldn't eat their meals—appeared to very listless and were constantly complaining about the odor I have observed that it affected their ability to sleep. I did quite a bit of delivery work, and we kept the windows closed continually because the odor was offensive. The odor was worse in 1939 than in 1938. It was absolutely terrible last year (1939). I think 1939 was really worse than this year (1940). I have noticed it this year but I noticed it particularly last year (1939). I myself was affected—lost my appetite—didn't have any desire to eat and at night the odor from the river was terrible. I have noticed this year (1940) they are unable to sleep due to the terrific odor. The patients have been complaining about this continually. It was a general complaint. I have had experience with patients requesting to go home prior to time their treatment was finished. They said they couldn't stand the odor—

that they couldn't even rest at night. I know of post-operative patients going home last year (1939) before
1346 the sutures were removed. They complained so about the odor and not being able to eat. I have noticed the odor prior to 1939 but last year (1939) it was unbear-
1347 able. When there are no odors the windows in the obstetrical room are, as a rule, not kept closed. They are closed only when there are odors. The odors during the summer time are constant—we have had them every day all day—and after a rain it is just terrible.

STIPULATION — It was here stipulated between
1349, 1355-1356, 1364-1365 counsel that the State of Illinois had 200 additional witnesses throughout Joliet who would testify substantially along the same lines as the lay witnesses who had previously testified.

Thursday, July 25, 1940.

1357 THOMAS J. TESTIM. I reside at 606 Oneida Street, Joliet, Illinois and have been a bacteriologist for 19
1358 years. I have made an analysis of the water from the Sanitary District Canal to determine the bacillus coli communis content.

1359 I took samples on June 4, 1940 between 3:30 and 4:30 P. M. from a barge south of Ruby Street; from a barge at Jefferson Street and from a barge on Lake Joliet about half a mile below Railroad Street on the west side of the lake. In making these tests I used the recommendation of the U. S. Public Health Service
1360 for determining the presence of colon bacilli. These different samples were cultured out in various dilutions, starting with the 1 to 100 dilution, following

through to 1 to 1000 dilution and also in 1 to 10,000 dilution, to determine the highest dilution the bacillus coli could be recovered in. The lowest bacillus coli content was found at Lake Joliet barge, which was positive in 1 to 1000 dilution, equivalent to 1000 colon bacilli per c.c. The highest dilution on that day was the colon content found at the Ruby Street barge which was positive in the 1 to 10,000 dilution, equivalent to 10,000 co-
1361 lon bacilli per c.c.

I took further samples on June 15, 1940 between 1:30 and 2:30 P. M. at the same places. The lowest bacillus coli content was found at South Jefferson Street and the Lake Joliet barges, which were positive in 0.5 c.c. of the 1 to 10,000 dilution, equivalent to 20,000 bacillus coli per c.c. The highest bacillus coli content was found at the barge at So. Ruby Street and the locks at Lake Joliet, positive in 0.25 c.c. of 1 to 10,000 dilution, equivalent to 40,000 bacillus coli per c.c.

I also took some samples on June 17, 1940 between
1362 the hours of 2 and 3 P. M. at the same places. The lowest bacillus coli content was found at Lake Joliet barge, positive in 1 c.c. of 1 to 10,000 dilution, equivalent to 10,000 bacillus coli per c.c. The highest bacillus coli content was found at So. Jefferson Street barge, positive in 0.25 c.c. of the 1 to 10,000 dilution, equivalent to 40,000 bacillus coli per c.c.

On June 14th, the bacillus coli averaged 5,000 per c.c.; June 15th, 30,000 per c.c. and on June 17th, 25,000 per c.c.

On June 14th the pyogenic cocci, staphylocicci and streptococci were isolated from 1 c.c. broth cultures of 1 to 10,000 dilution of the Ruby Street barge sample

showing them to be present in concentrations greater than 10,000 per c.c. These counts represented a conservative estimate of the bacillus coli content as the samples were taken between the surface and a depth of 12 inches. Inasmuch as considerable sedimentation of fecal material takes place in this slow-moving stream the colon content should be much greater at lower levels. These samples were allowed to stand at room temperatures for a few weeks, after which cultures were again made to determine the bacillus coli content. The June 14, 1940 sample from the Jefferson Street barge was recultured on July 2, 1940 and showed the presence of 200 bacillus coli per c.c. after this 18 day period—the original June 14th count showed 4000 per c.c.

The Lake Joliet barge sample taken on June 15th was recultured on July 6, 1940 and showed the presence of 400 bacillus coli per c.c. after 21 days. The original count showed 20,000 per c.c.

The Jefferson Street sample taken on June 17th was recultured on July 9, 1940 and showed the presence of 1000 bacillus coli per c.c. after 22 days. The original count showed 40,000 per c.c. These tests show it would take a long time for this sewage to sterilize itself, taking into consideration that no further contamination would take place.

The U. S. Public Health Service standard for potable water permits the presence of 1 B. coli in 100 c.c. of water. In other words 1 c.c. of the Ruby Street barge sample taken on June 15th, containing 40,000 bacillus coli per c.c. would render 2,000,000 c.c. of pure water unsafe for drinking purposes.

The foundation of Joliet is limestone. There was

considerable blasting done at the time the deep waterway was constructed and a survey of wells prior to the time in which the supply had been shown to pass the U. S. Standard for potable water, later showed contamination upon completion of the waterway. I am led to believe that this blasting created fissures in the rock which caused the contamination of these wells. I would say that sewage of the concentration to which I testified offers a great hazard to the wells in the vicinity of
1367 the deep waterway. The only way to eliminate the danger absolutely is to eliminate all sewage coming down the waterway and if that isn't possible, dilute it as much as possible or prohibit the people from using well water. That has been done in the city of Joliet, but there are wells in the city not more than three blocks from the courthouse where people do not have city water supply.

1368 The City of Joliet gets its water from deep wells—approximately 1600 feet deep—located in various parts
1369 of the city. There is one on Jasper, East Washington, Ruby, Williamson and Ottawa Streets. This water isn't piped to all parts of the city. The city of Joliet dumps its own sewage into the canal below Brandon locks.
1370 We have had no typhoid conditions in the city recently that I know of. There are no towns below the dam. It is a farming community below until it (the waterway) meets the Kankakee River and forms the Illinois.
1372 The Jasper Street well isn't being used right now. Whenever the city requires it, they use that well.
1373 They are using only two wells right now—the East Washington Street well and the Ottawa street well. I believe the water from the Ottawa Street well is rea-

sonably safe and as safe as any water could be, and that
1374 the water in the East Washington Street well is as safe as reasonably could be expected. I believe the Jasper Street well, since it has been recased, is safe and fit for public consumption. I believe an adequate remedy in the case of isolated, individual wells which might be affected by the Illinois Waterway would be to require them to close those wells and to use the city
1378 water supply. The State Health Department has warned the city to chlorinate the wells to be on the safe side, and they are chlorinated now—the two wells
1379 that supply the city right now. The State Health Department checks the City of Joliet's water supply at
1380 intervals. The Jasper Street and Ruby Street wells have tested safe but I recommend that whenever water is used for drinking purposes it be chlorinated as an
1381 extra precaution. Right now the city is not using them.

The Master would be right in finding: (1) the Jasper and Ruby Street wells are not being used by the city at the present time; (2) if they are used they would be chlorinated; (3) if they are used and chlorinated they would be safe; (4) if the city needed more water it
1382 could build more wells; (5) it would cost approxi-
1383 mately $30,000 a well to drill two more wells. They have ample water to supply everybody from the present wells in use and operation.

1384 It would be correct to say that this canal has always been a potential menace all the time that open sewage is carried in an open canal like this and that theoretically it is very undesirable. We have had this potential menace for 40 years. The blasting has opened

some fissures and increased the menace by a small
1385 amount. Of course the amount of sewage has been diminished by the construction of the treatment plants in Chicago, while on the other side of the picture is a reduction of the amount of water out of Lake Michigan.
1389 If the Supreme Court ordered the flow from Lake Michigan increased from 1500 to 5000 feet I would say
1390 that the danger had been decreased in the ratio of 50 to 15. There would still be a source of contamination—you might go along with for a good many years and still might cause some typhoid—I would simply say that the danger has been reduced. If the flow were decreased considerably below the average in the warm
1391 months, the ratio would go up considerably. If they have a fissure in the rock in which there is a leakage of 1 c.c. an hour, granting that the leakage takes place at that rate regardless of the volume of water going through, you have diluted your infection to the extent to which you have increased your flow.

Additional treatment of the sewage of the City of Chicago, and treatment by the municipalities of Argo, Summit, Lockport, Lemont and others lying northwest of Joliet, and treatment by the State of Illinois of the sewage of the two penitentiaries, would furnish addi-
1393 tional safeguards. I am not familiar with the lime treatment method, but any method of filtration would
1394 considerably decrease the bacterial count, the hazards, if properly supervised. It is a fact that biological processes take place in the canal that are not duplicated in a bottle test. I would say that the analysis of the three samples which I collected would represent a conservative estimate of the presence of B. coli in the

canal during the summer months. The number varies in relation to the treated sewage. Tests can be taken only over a short period of time and even now they may not be exactly identical with figures taken from
1395 the tests I made. I do not think a sample taken near the surface and containing scum would show a higher B. coli content than a sample taken at greater depths then one foot. The scum is acted on by the sun and the sun is germicidal to a certain degree, and the farther you get under that scum the greater protection those
1397 organisms have against any germicidal effect of the sun. Chlorination could improve considerably Brandon Road pool, but wherever there are solid amounts of fecal material in there I do not think you could get 100 per cent sterilization. I think it would be possible to improve it to an extent sufficient to offset such damage
1398 as may have been caused by a diminution in the diversion from the lake. That would also reduce the odor in Brandon Road pool.

OBSERVATIONS OF THE MASTER ON THE DEEP WATERWAY
WEDNESDAY, JULY 24, 1940

7:00 o'clock P. M.

Pages 1088-1098

1088 On Wewnesday, July 24, 1940, at about 7:30 P. M., the Master, accompanied by Messrs. Naujoks and Herbert, representing the opposing States, and Messrs. Babcock and Zimmerman, of the Illinois Waterway Division, (Messrs. Clausen and Wallenstein were invited to come here with the Master but were not able to do so because they had to make arrangements for witnesses to attend the next day) embarked at the Jackson Street bridge on a speed boat and set out upon an inspection of the canal headed south. An odor was perceptible, distinctly perceptible, when the party drove over the bridge before we embarked, and was likewise perceptible at the edge of the stream when the motor boat began to move.

When the party reached mid-stream the odor was no longer perceptible. There was a light southwest wind.

I will dictate as I proceed.

We are now going under the Cass Street Bridge. There is no very thick scum perceptible. Mr. Babcock of the Illinois Waterway Division remarked that there was very little scum tonight. There are perceptible on the surface of the water various little strips of what appear to be greasy substance, said to be oil patches.

1089 We are now under the Jefferson Street Bridge.

We are now under the Rock Island Railroad Bridge.

We are now proceeding under the McDonough Street bridge.

We have now, at the suggestion of General Herbert, turned about and proceeded upstream to the side of the canal in order to get a close look at the scum on the side of the Waterway.

We are now proceeding to the east side, which is the right hand side. There is visible along the walls here for a strip of two or three feet in width, all along the wall, a thick, rather thick, surface layer which appears to be scum, which contains a good deal of pieces of wood and pieces of paper and other miscellaneous debris and a good many grease spots. The odor is not bad. There is an odor, but it is not strong and at this point one does not feel the breeze which perhaps is now behind us, but there does not seem to be much breeze at all. I don't see any scum collected on the side of the wall.

We have now turned about again and have gone under the McDonough Street bridge.

We are now in the Brandon Road pool, according to
1090 Mr. Babcock. The width of the stream is, at this point, perceptibly greater than it was before we passed under the last bridge.

We are skirting the left side and see a rather thick scum here extending perhaps 10 feet, which as we go on increases in width to perhaps 20 feet. I detect no odor at this point, perhaps due again to the breeze. I see a number of bubbles on the water which I understand represent the operation of the gas from the sludge underneath the surface. These bubbles are apparent all

over the whol width of the Waterway. No odor is perceptible at this point.

There does not appear to be any coagulation along the wall itself and the scum would certainly not bear any pressure at all.

I now, about half way down the length of the pool, get a whiff of an odor which continues as I dictate, is perceptible, would not seem to the Master terrible or particularly bad, but is noticeable. This odor continues now, I can detect the odor. I do not think it would affect me even if I had to continue breathing it.

We are now opposite the waste gates where the surplus water from these pools goes over into the Des Plaines River.

1091 We are now crossing to the west bank.

Will you note now that we went all the way down to the lock and turned about and are now proceeding north nearer to the west side of the canal. There seems to be now a current in this pool as far as one can tell by the naked eye.

There is now a perceptible breeze from the southwest.

It is now about 8:00 o'clock Daylight Time, and the sun is now beginning to set.

I see no perceptible scum, but I see gas bubbles all over the surface of the canal. I am informed by Mr. Babcock that the crew on the boat say there is no scum today but that they came down here a few days ago and there was scum all over the water but the wind must have blown it all off today.

Mr. Zimmerman, also of the Waterway Department

says this is really a favorable day although a very hot day.

I now catch the odor which I lost a while back. It is perceptible but would not bother me very much but it might bother others and I certainly would not call it pleasant but it is not strong.

I have now lost the odor again entirely as we are
1092 proceeding away from the side over in the middle of the Waterway, but I now see in the middle of the Waterway a considerable scum extending across the Waterway but I detect no odor. My impressions seem to check with the other members of the group on the boat, including the court reporter and the Waterway people.

There is now not so much scum.

We are now proceeding under the McDonough Street bridge and leaving the Brandon pool. As we go under the bridge I catch a whiff of an odor, which is gone in perhaps a minute.

I see a good many small patches of grease on the surface of the water.

Now as I get under the Rock Island Railroad bridge I get another whiff of an odor, but it has disappeared again in a few seconds.

We just crossed under the Jefferson Street bridge but about midway to the next bridge we stopped and turned about and approached the east bank and I got a slight odor which I catch again every few seconds as we proceeded back to the bridge and alongside the wall, but it is not continuous.

1093 As we circle around turning again I catch the odor, distinctly, somewhat more strongly, and it persists for

perhaps a minute until we pick up speed and seems to disappear.

We are now under the Cass Street bridge but I detect no odor here, but after a minute I catch an odor which has again disappeared.

We are now passing St. Joseph's Hospital. The Master just caught a spray of water from the operation of the propeller. No odor perceptible as we pass by the hospital, but as we near the Jackson Street bridge we pick up an odor but it is suggested that the piling of the bridges may catch up some of the debris and the scum. Mr. Babcock also suggested if we would stay along the walls continuously we would detect more odor than in the middle of the stream.

We have now gone beyond the point at which we embarked and are approaching the Ruby Street bridge. I catch an odor as we near the bridge, which is not strong, gets a little stronger as we go under the bridge and persists for perhaps a minute, which is longer than it has persisted at any other stage.

We are now passing the junction with the Illinois
1094 Michigan Canal.

I have observed no flies or mosquitoes on the trip so far.

I now catch the odor again, but only for perhaps less than a minute.

Mr. Babcock informs me that we have been going at an average speed of 18 to 29 miles an hour. I now pick up an odor which is rather faint.

We are opposite the Ruberoid Plant. I see considerable scum in the middle of the Waterway and catch a faint odor. The scum seems to extend along the cen-

ter of the canal, a strip perhaps 10 or 15 feet wide, and more scum toward the east of the canal.

I see fewer air bubbles.

In about a minute I have lost the odor again. We have now picked up the odor again in another minute.

We are now approaching the E.J.E. Railroad bridge. The odor has now disappeared again before we get under the bridge, but I pick it up again in half a minute and it persists as we get nearer to the bridge.

As we go under the bridge it is very slight. Now I
1095 pick up the odor again, just after we leave the bridge, quite perceptible as long as at any time.

We are now nearing the coke plant of the American Steel & Wire Company. The odor here is not perceptible. There seems to be less scum.

I now catch the odor again as we are just alongside of the plant, but it is not strong but it is persisting for a couple of minutes, perhaps for a longer spell than any spells so far.

There seems to be a perceptible current in the water and little scum now observable.

We are now approaching the lock at Lockport, and the odor is perceptible. It is now 8:30 Daylight time, and the sun is almost setting.

I catch an oil odor as we pull alongside the east wall of the Waterway right at the lock, but I also detect an odor from the canal. The odor from the Waterway is distinctly perceptible here as the boat is turning about now to return to Joliet.

Now as the boat is turned about and we are headed south, I have lost the odor.

As we go down-stream we have a nice breeze, per-

haps due to the motion of the boat now, but not much more than we had coming up-stream, and I catch no odor.

We have now gotten back opposite the Ruberoid Plant. Up to this time I had caught no odor and I asked that the speed of the boat be reduced to about 5 miles per hour to see if the speed had something to do with my not catching the odor. I catch now a slight odor and it goes and comes. I catch it for a few seconds and then lose it and catch it again. I see grease spots but notice no scum. It is growing dark but still daylight. I have now lost it again after a minute or two altogether. I now pick is up again for a few seconds at a time. It seems impossible to hold it long.

We are now opposite the function of the Illinois & Michigan Canal, which is practically grown up in weeds. I understand it re-emerges on the north side of the Brandon Locks and is open from that point to La Salle, Illinois independent of the Waterway, and unnavigable.

We are now under the Ruby Street bridge and I caught no odor. There seemed to be just a whiff for just a second but it disappeared almost immediately. I pick it up again as we are about a minute past the Ruby Street Bridge still going about 5 miles an hour, and now I have lost it in a few seconds. I think I catch it again in a few seconds and hold it for perhaps 20 seconds and lose it. It is not strong.

We are now approaching the west bank of the Canal at the point at which we embarked and I have lost the odor.

I catch no odor as we tie up. It is now 8:45, the

lights of the town are on, but it is still light enough to read.

We will remain tied up as there appears to be a boat coming through on the south end and we may observe the effect of the passage of the boat on stirring up the water. So far I have not observed any flies tonight and had only one mosquito bite.

As we are tied up now along the west side, I am not troubled by any mosquitoes or flies.

Note that we discovered the boat that we were waiting for was tied up. We got into the automobile and drove across the Jefferson Street bridge. The boat had apparently passed under the bridge and was tied on the north side of the bridge. We had crossed on the Jackson bridge to the east side and we recrossed on the Jefferson Street bridge to the west side but caught no odor.

1098 Now we are driving on the west side of the canal on iHckory Street about two blocks from the canal, down to Cass Street.

Now we turn east to cross the canal again. We have had no odor so far since we got off the speed boat. There seems to be little air in motion.

It is about 9:00 o'clock as we cross now again over the Cass Street bridge. We caught nothing until just as we were getting on the east side when for a second we got a whiff which lasted only a second.

We are now coming to the town without any odor.

We are now disembarking at the Louis Joliet Hotel.

Testimony of Witnesses from Lower Illinois River Towns

September 24, 1940

MASTER'S EXAMINATION

2332 GEORGE PATRICK MOORE. I live at 221 Wiswall Street in Peoria. I am Secretary of the Pleasure
2333 Driveway and Park District of Peoria. One of our parks—Detweiller Park—has approximately 13 city blocks of frontage on the Waterway. Our park properties are upstream from Peoria. I would not know how far south of Joliet. Any statement I might make relating to health conditions would be purely a layman's. I have and still do spend a considerable amount of time on the river—both myself, Mrs. Moore and my
2334 two children. For the last year or two there has been quite a lack of odor that was formerly very noticeable, particularly directly on the shorelines. For six or seven years—from about '32 or '33 along in there—there was a decided odor that was apparently foreign to the stream odors we might find on the stream, such as dead fish or vegetation. That has been missing and we naturally began to wonder why. We began to believe that possibly there was a smaller amount of undesirable ele-
2335 ments coming down the river. We believe there isn't as much sewage and sludge coming down as there was prior to that.

I, personally, Mrs. Moore and our friends have observed an improvement in the condition as to odors the last two summers; the present summer we are now

closing (1940) and last year (1939). The summer before (1938) hasn't been discussed. I wouldn't say that we had only begun to discuss it since we heard that Illinois was trying to get more water. I think the question of Illinois getting more water came out after we got a little interested and began inquiring around.

2336 I don't know what the improvement in odors is due to, but my own personal feeling is that improvement in treatment of sewage at Chicago is minimizing it. There isn't as much as there was. Our interest is that that condition should continue as it now is and not revert to the condition of old. Even though those odors might never have been caused by anything that was dangerous to health, they were offensive.

Cross Examination By Mr. Clausen.

2338 During a week spent on the river in '39, Mrs. Moore brought to my attention the difference (in odors)
2339 and from then on I began observing it myself.

The Master

I couldn't say there was any degree of improvement this year (1940) over last year (1939).

2340 As between the two years '39 and '40 I see no change between them, but I think both of them were better than preceding years.

Mr. Naujoks.

I haven't swam in the river, with the exception of an emergency or occasionally a little recklessness in hot weather—I happened to be out fishing and go over the side of the boat. I don't permit my children to. This is on general advice of one or two of my friends who happened to be physicians and don't permit their own children. They felt the river wasn't quite safe.

2341 There is general bathing down there now. There is a beach about four miles from the cottage I stayed at this year, right on the Illinois River.

The Master.

People have gone in bathing for years. I wouldn't know that more of them went in bathing this year and last year than in previous years. It looks about the same number in every year to me. To my knowledge

2342 none of this water is used for drinking. I am here just as a citizen and am not a representative of any organization.

September 24, 1940

Master's Examination.

2344 THOMAS H. DETWEILLER. I live in Peoria. I am a park trustee and also in the ice business. I heard the statement of Mr. Moore here a few minutes ago.

2345 I just want to tell you what the conditions are

at the bottom of the river, and also that the wells from which we get our water supply are located along the river. Suppose a fault occurred in the bed of the river and that water would get into our supply, it would contaminate it and be a danger to us.

We have, of course, been exposed to that danger for many years. The sewage has been coming down that Waterway for 40 years or more—the last 30 years real bad. We have noticed a change in conditions in the last two years. Six months after they cut the diversion down you could notice a better condition in the river. They commenced getting some fish. There had been no fish before then.

2346 I own some property right next to the Peoria area of the U. S. Engineers. They had a little spot they wanted to fill with dredging. They had more dredging than they could take care of and I let them pour some of it over my land. It came out of a 14 inch pipe, a sediment just like tar and you could smell it about 300 feet away. That was two years ago, and I suppose that would be equally true today. Last January (1940) when the lake was froze over I got curious and we took two men and chopped a hole in the ice. We had a 24 foot 2x4 rough so whatever it touched would stick. When I let it down and hit this muck you could feel it.

2347 Then we used all our strength and pushed it through to the hardpan. When they pulled it up there was five and one-half feet of that. Some of it was black and some of it was green.

Cross Examination By Mr. Clausen

This muck they took out and put on my land was very offensive. When it dried it looked like asphalt pavement. You could smell it 300 feet away. The area on which they were putting this muck was 150 x 400 feet. It run right back into the river, some of it in liquid shape.

2348 My concern is I feel if there is more water that comes down there is apt to be more odors given off around Peoria, because now, with the water cut down, the heavier solids stay in the upper region of the river and if you get more water it would wash it down.

September 24, 1940

Master's Examination

2351 DR. J. P. KERR. I live at Versailles, Illinois, approximately 90 miles south of Peoria, and about 250 miles from Chicago. I am a farmer and I have a farm on the Illinois River bottoms and I have lived there for 35 years. I represent the Association of Drainage and Levee Districts of Illinois. It comprises people owning properties and farms in the Illinois River Valley—possibly a thousand people. I have been representing these people for approximately 20 years consecutively. I have known the officials of the Sanitary District more or less for the same period of time and have associated with them in their work in Washington and Springfield.

2352 No one city or position on the Illinois River can be

considered a part by itself. What is done at Joliet affects the river more or less all the way downstream. What happens in the cities on the stream above Peoria affects us materially a hundred miles south of Peoria, so the river must be considered, technically, as a whole.

It has been proved beyond a doubt that increased diversion and dilution water does not solve the sewage disposal question. It has taken twenty years to prove that truth in the Illinois River and so when it comes to a question of solution of the problem confronting Joliet it is not a question, from our point of view, of dilution or increased diversion. There are other factors that enter into the problem.

All of us downstream have known this river dur-
2353 ing the entire period—going back to 1912 down to 1936, '37, '38 and '39, and so when we ask the question about the public health being jeopardized at Joliet we may make comparisons of other conditions on the Illinois River when conditions were far, indescribably worse than they are at Joliet today.

During the long period when this system of maximum diversion of water down the Illinois River was followed, it is an established and well-known fact from one end of the river to the other that the great islands of floating, untreated sewage were discoverable all the way down through Joliet, through all those upper cities of Marseilles, Morris, Ottawa, Peru and Henry, and even down to Peoria untreated sewage particles
2354 were discovered on the surface of the river. I live 250 miles from Chicago or 100 miles from Peoria, and this odor was discoverable at my place, very offensively so, and the people in my neighborhood ceased to visit the

river for a rest during the summer months, the river was so foul and intolerable. There was an immense amount of sedimentation of this sewage all the way down to Peoria and during spring months that sedimentation would arise in floating islands and float down the Illinois River into the Peoria area. At that time there was a sanitarium for tubercular people at Ottawa. Ottawa is removed somewhat from the river—say a half mile or so and even though that odor was intolerable to those poor people it did not sicken any of them or cause any of them to die.

During the maximum diversion, fish life was practi-
2355 cally exterminated from Peoria up. From Peoria down the fish continued to live, but at my point, although we were regular consumers of fish, fish were not edible. They were sewage saturated and offensive even to handle in their preparation, so we did not use them.

That was the condition that continued throughout the entire river during this period. It was intolerable for any of the young people to bathe in the river anywhere, even down to my place. I absolutely prohibited my son from going into this river at this time.

Notwithstanding this intolerable, unspeakable, indescribable, inhuman condition, we know of no case of
2356 any menace to human life during those years. We watched that condition carefully, so there is no point to the question of foul odors in a river affecting the human welfare or human health. I took the trouble to appeal to the Public Health Service at Washington on this very subject.

2358 Now we want to call your attention to the fact of the river as it is today with the reduced diversion

and with several factors not yet put into effect that might improve the river. In an article by W. H. Wisely and Clarence W. Klassen, Assistant Sanitary Engineer and Chief Sanitary Engineer, Illinois Department of Public Health, entitled "The Pollution and Natural Purification of the Illinois River Below Peoria" reprinted from "Sewage Works Journal", Vol. X, No. 3, May 1938, it is said on page 1:

2363 "On the other hand, through the efforts of the Sanitary District of Chicago, satisfactory conditions now exist directly above Peoria in the Illinois River and for many miles upstream."

That is the foundation of what I have to say today in its relation to this Joliet Pool, that the entire river situation has changed so very materially. The condition of floating sewage on the river surface as far south as Peoria to which I referred yesterday, is entirely eliminated. I have failed to find that there were any floating particles of sewage of any kind, even at Joliet. Fifteen years ago, during the time of the maximum diversion, there were evident at Beardstown, 300 miles from Chicago, certain floating fibrous materials in the
2364 river that were observable by the naked eye. That was more or less dissolved sewage. That, of course, is not so at all now.

It is also apparent that river plant life is beginning to appear on the lower river which was entirely destroyed during those years of maximum diversion.

The presence of sedimentation in the Brandon Pool

is not unusual. That is true to this day all the way down to Peoria, but it is gradually being removed by bacterial action and the action of the boats going up and down the stream.

Today our fish life is almost normal compared with former years so far as the fish being upstream. For-
2365 merly there were no fish to speak of north of Peoria. Today the fish are quite edible throughout the entire stream, and I am reliably informed by parties living in Ottawa that there is actual commercial fishing at that town. I am also advised that bass are found at this point ad bass will not survive in unhealthy conditions, so their presence is mighty testimony to the present condition of the river.

Today bathing is practiced all the way up to Peoria, freely and without restraint. I don't know whether they bathe farther north than Peoria or not. From our point of view—downstaters—the river is beginning
2366 again to look normal, even up at Joliet. The river at Joliet 15 and 20 years ago was just an immense, inconceivable open cesspool. This is not so today. We have failed with the exception of very warm days to discover any serious odors.

These conditions have come to pass despite three outstanding disturbing factors. First, the last three or four years have been remarkably dry years. Second, the diversion has been reduced during the last two years to 1500 feet, and in addition to these facts, all of the cities with the exception of Peru, which includes Joliet, Lockport, Lemont, Marseilles, Morris, LaSalle, Henry,
2367 Hennepin, have discharged their untreated sewage into this Illinois River.

How can this be so? There is only one answer. The Sanitary District of Chicago has increased its reduction plants, has treated its sewage to a greater percentage of purification and has so materially reduced the pollution of this stream that conditions now are becoming more or less normal, proving to our minds that it is not a question of dilution, but it is a question as to how much pollution is put in or kept out of this river. We downstaters feel that there is no excuse for any increase in
2368 diversion to take care of the situation at Joliet. We regard this entire procedure as a smoke-screen. We don't consider that there is any problem at Joliet. The Supreme Court spoke in 1930 declaring that this diversion should be reduced to 1500 feet. Since then there has been a continuous effort made in Washington by different parties to modify this decision by asking for increased diversions up to the 5000 limit. The excuses given for this increased diversion were for navigation. I think three or four distinct bills were introduced and were refused passage or approval on this
2369 plea for navigation. Now the plea has come up for sanitation. There are several very valuable power sites on the upper Illinois River, including Joliet, and increased diversion—a large amount of water—is of great value from this point of view. The question is now: Shall we be allowed to hold the Illinois River in its present favorable condition, or shall we be obliged to return the river to a condition of open sewage as it was before, by increased diversion. Peorians fear that if more water is turned into the river, more sewage will be turned into the river. They also fear that more of this

sewage will be carried downstream and deposited in their front yards.

2374 We feel the people of Joliet are not suffering any harm and that public health is not jeopardized, and that by pursuing the present methods of the treatment of sewage and keeping the river clean the entire situa-
2375 tion will take care of itself beautifully. It has been my observation all the way up and down the stream that the odors in Peoria and in the neighborhood were less offensive in 1939 after the reduction of flow. We had no odors this past summer (1940) and no odors the summer before (1939). 1938 is a little back in my memory.

Cross Examination By Mr. Clausen

2376 The first bill introduced in Congress to increase the water was within the last decade. The first large bill for 10,000 feet was introduced by Mr. Rainey along back in '20, '22, '3, '4. I opposed the increase then and have opposed it consistently twenty years.

2382 If one could imagine it would not injure, I would not be opposed to an increase of diversion of water from 1500 to 5000 cubic feet per second, but I refuse to believe that it could not prejudice us.

2383 Witness has been a militant objector to water from Lake Michigan for the past 30 years because of its pollution and other effects.

September 25, 1940.

Master's Examination

2385 HARRY L. GOODELL. My residence is Beardstown, Illinois, I am a practicing civil engineer. I am a graduate of the University of Illinois in the year 1925 from the College of Civil Engineering, and I have been actively engaged in civil engineering for 15 years. About half that time I was engaged in municipal work and the other half I was employed by the Corps of Engineers in the War Department on the construction of locks and dams on the Mississippi River.

I have been employed by eleven drainage and levee districts and represent those organizations.

2387 In 1914 swimming was the usual thing in the Illinois River, perhaps against the advice of parents due to the condition of the river, in other words, there was evidence of pollution.

2388 I was 12 years old, and from 1914 on through during the war, in the '20's I continued to swim and work on the river and travel up and down the river on excursion boats. I never knew of anybody dying as a result of swimming in that river that was directly attributable to the pollution. A younger brother, at the age of 6 was swimming in the river at Beardstown and he got water in his lungs and was seriously ill immediately after that. He recovered. That was in 1919.

2389 There was one serious infection that I know of at the same time, about 1918 or 1920. The people got well.

2390 In 1918 I began to work on the river and live on the

river in quarter boats. We couldn't use the water for drinking or washing or anything like that, and there was evidence of pollution even in low time when ordinarily the streams are clear—there seemed to be a continuous, more or less of a boil in the river, of always cloudy and very fine sediment in the river. That was evident as far as Beardstown—perhaps further. My experience with the river has usually been from Beardstown upstream in detail, you might say, to Peoria, and a general knowledge from Peoria into Chicago. Beardstown is 80 miles south of Peoria and 200 miles from Lockport by river.

2391 During the '20's we didn't eat the fish from the Illinois River. Then during the '30's we have had a gradual improvement of our water conditions. It has been gradual all through the decade, and our water condition at Beardstown is now very much improved. We do bathe in it, but I wouldn't say it reaches the requirements of the Public Health Department as to bathing places.

2392 Acquatic plant life is beginning to return. There is one plant—I don't know the name of it—but it is associated with bass fish. Today practically all the fishing on the Illinois River is in the Peoria pool. I think there are two reasons for that. One is there is an improved water condition in Peoria Lake, which is now the largest body of water in the lower river, and the other reason is that during the past spring we did not have a flood on the lower river to such an extent that it was necessary to drop the gates of the movable dams in the river.

I have observed the condition of the upper river from the head of Peoria Lake on into Chicago since the

2393 20's, and it is my observation that the condition was very bad during the '20's and, say, up to about the time they started reduction plants, and now it has gradually improved during this 10-year period. At Joliet I won't say it is any better but I don't think it is any worse. To my knowledge there have been no epidemics along the river during the 20's or '30's either at Joliet or below Joliet down to the head of Peoria Lake.

2395 A sewage plant was designed and constructed and placed in operation at Decatur, Illinois on the Sangamon River in 1924. The town has a population of 40,000. They had an industrial situation there that at that time made the population of Decatur equivalent to about 300,000 which was not, apparently recognized in the design and construction of the sewage treatment

2396 plant. Consequently the Sangamon River immediately below and for at least 40 miles down stream was very highly polluted due to inadequate treatment. I worked in that for days and weeks, and this stream had highly offensive odors, and we experienced no disease. We had six or eight men working there for weeks and no ill effects from it. Of course, if we had a scratch we always washed our hands in alcohol at night to prevent any infections. About 12 miles below Decatur there was a well-painted house within about 150 feet of the stream. When the pollution came along you might say it just turned the paint black. It was a cream-colored house. The people lived there and they had no ill effects from that.

2397 That waste from Decatur was sewage and starch wastes—it was a mixture—they all came through. The

starch was a high industrial load. To my knowledge there was no epidemics in Decatur.

2398 There is a boat from Beardstown operating up here on the canal—a tow-boat, which traveled back and forth through the canal—mainly down to Brandon Pool—and they cook and eat on the boat, prepare their meals and to my knowledge there has ben no ill effects from that. To improve conditions at Joliet I am sure that the construction of the plants to be completed can be speeded

2399 up materially. Second, take the power generated at Lockport to run air compressors or air-producing machines to aerate the water in the tailrace at Lockport. Then I think it is practical to periodically flush the Brandon Pool. I am thinking of flushing the Brandon Road Pool with the same flow that they now have—in other words, periodically drawing that pool down.

2400 It is a difficult question to answer as what effect it would have downstream—whether this offensive material now accumulated in Brandon Road Pool would find its way downstream—because you get into the question of reaeration of streams and dilution. I don't think it will have a material effect on the river, even at Peoria. The organizations I represent would offer no objections to that. They would not object to flushing the sludge into the lower pools—the Dresden Island Pool—the Marseilles Pool or the Starved Rock Pool. I think by the time it passed Starved Rock it would be fairly well decomposed, or at least some action would take place where the condition would not be offensive or a menace.

Cross Examination By Mr. Naujoks

2402 I have not made any studies to determine the effect of an additional 3500 cubic second feet of water on additional polluted water or sewage being carried down toward Peoria. From my experience we know that with the larger diversion in the past the sewage was carried down, noticeable in Beardstown and the Peoria Pool. In the '30's the diversion has been reduced and the river has been improved, so I would say that any increased diversion would reestablish the polluted condition at Peoria and Beardstown. It is my opinion that the center of pollution was carried back toward Chicago with the lower diversion while if you increase the diversion the center of pollution would go down stream more. As to the quantity of increase—the point it would
2403 reach—I am not able to say but we want the waters of the Illinois River restored to their natural quality and quantity. It is my opinion the proper way to accomplish that is by complete treatment rather than dilution.

The Master.

I think the population of Peoria is roughly about
2404 100,000. Beardstown has a population of 6300. The country along the waterway is a rural section—sparsely settled, except at Joliet and Peoria. Even below Joliet there is Ottawa and Peru and Marseilles and several little towns on the waterway within a distance of 60 miles.

Mr. Clausen.

2405 Improved conditions now noticeable below Joliet are due to the increased treatment rather than to the reduction in the flow of water. The Peoria plant was placed in operation in '39, I think.

2406 Before that time you couldn't very well distinguish between the sewage of Peoria or the sewage of the Sanitary District except there has been a gradual improve-
2407 ment in our water condition at Beardstown through the whole decade. The improvement in our case might also be due to the treatment of the sewage at Peoria.

I can't say that there has been any change in our conditions in 1940 and 1939 as compared with preceding
2408 years. The condition is gradually better. I can't say whether there is any marked difference between '39 and '40. I don't think from year to year it is so distinguishable as it has been over the period.

Beardstown pumps its sewage directly into the river below Beardstown. We have 6300 population with a larged flow at Beardstown because we are below the largest tributary. There is a very large question as to whether or not we do actually pollute the river under
2409 the definition of pollution as set up in the statute. The population at Versailles is just a small village—a hundred or two.

Mr. Naujoks

The minimum flow of the river at Beardstown right now is in the neighborhood of four or five thousand cubic second feet. Our maximum runs in the neighborhood of 100 and 110 thousand, so we get quite a high dilution with the volume of sewage we put in there.

We have had no odors at Beardstown this summer,

sewage odors. You get ordinary river bank odors—dead fish life, and so forth.

When I was a boy I did not notice any odors that I could directly attribute to the sewage. However, you could see from the water that it was a polluted stream.

2410 I wouldn't say that we had any actual odor trouble at Beardstown. I am not so sure about Peoria. There were odors above Peoria due to, perhaps, sludge settlement. I am not familiar with that in so much detail.

Respectfully submitted,

GEORGE F. BARRETT,
Attorney General of Illinois,
JOHN E. MARTIN,
Attorney General of Wisconsin,
J. A. A. BURNQUIST,
Attorney General of Minnesota,
THOMAS J. HERBERT,
Attorney General of Ohio,
CLAUDE T. RENO,
Attorney General of Pennsylvania,
HARRINGTON ADAMS,
Deputy Atty. General of Pennsylvania,
HERBERT J. RUSHTON,
Attorney General of Michigan,
JAMES W. WILLIAMS,
Assistant Attorney General of Michigan,
JOHN J. BENNETT, Jr.,
Attorney General of New York,
TIMOTHY F. COHAN,
Asst. Attorney General of New York,
HERBERT H. NAUJOKS,
Special Assistant to the Attorneys General.

Filed: April 30, 1941